self that in the polypes mentioned above, the inner surfaces of the polype-cells, of the appendices of those processes described in the *Cellularia reptans* and *scruposa*, of the bird-head processes, of the spines, and of the canals running along the lateral surfaces of the polypidom in *Flustra avicularis*, are all lined by a fine membrane. This membrane in old specimens, and when the polypes are dead, often presents numerous and pretty large cells, generally of a pale colour, at other times having a slightly yellowish or brownish tinge, adhering to its free surfaces. In one specimen these cells had accumulated in such quantities within some of the spines in *Flustra avicularis*, as to produce considerable bulgings and excrescences. The growth and nutrition of the hard parts of the polypidom must be chiefly due to this membrane.

EXPLANATION OF PLATE XII.

Fig. 1. Magnified view of the posterior portion of the upper end of a branch of the polypidom in *Cellularia reptans*. It is slightly elevated on the left side, so that the polype-cells of that side are better seen than on the other.

Fig. 2. Three appendices to the cells in *Cellularia reptans*.

Fig. 3. Magnified view of four polype-cells of *Cellularia reptans* seen on the anterior surface.

Fig. 4. Magnified view of polype in *Cellularia reptans* when folded up in its cell.

Fig. 5. Magnified view of this polype when expanded.

Fig. 6. Magnified view of the anterior surface of the upper part of one of the branches of the polypidom in *Cellularia scruposa*. The polype-cells are in this drawing also more distinctly seen on one side than on the other.

Fig. 7. Magnified view of three appendices to the polype-cell in *Cellularia scruposa*; *b*, *b*, *bis*, views of the process bearing the hair-like prolongation in two different positions.

Fig. 8. Greatly magnified view of head and upper part of stalk in *Pedicellina echinata*.

Fig. 9. Greatly magnified view of the ciliated ova of *Pedicellina echinata*.

Fig. 10. Magnified view of polype in *Crisia chelata*.

Fig. 11. Magnified view of polype-cells in *Alcyonidium parasiticum*.

Fig. 12. Magnified view of bird-head process in *Flustra avicularis*.

Fig. 13. Magnified view of ova in *Flustra avicularis*.

XLIV.—*Observations on the* Spongiadæ, *with descriptions of some new genera.* By J. S. Bowerbank, F.R.S., L.S. &c.

[With two Plates.]

The microscopical examination of several hundred species of the *Spongiadæ* has led me to believe it possible that a series of characters may be obtained from the anatomical structure of the skeleton, which, from their constancy and striking peculiarities, will enable us to establish genera, based upon more certain cha-

racters than those which have hitherto designated the numerous and extraordinary species of these singular animals.

Lamouroux, in his 'Histoire des Polipiers Coralligènes Flexibles,' has described 163 species of *Spongiadæ* under the common generic designation of *Spongia*, basing his descriptive characters principally upon form and colour. It is almost unnecessary for me to say, that there is scarcely one of these descriptions which can be applied with any degree of certainty when we attempt to identify specimens of recent sponges.

Dr. Fleming, in his 'History of British Animals,' taking advantage of the valuable labours of Dr. Grant, has divided the *Spongiadæ* into a series of genera founded, to a certain extent, upon their anatomical structure, and taking the common officinal sponges as his type, has described the characters of the genus *Spongia* in the following words:—"Porous, the cartilaginous skeleton simple or destitute of earthy spicula."

Dr. Johnston, in his admirable 'History of the British Sponges and Lithophytes,' has added considerably to these characters, and has thus designated the genus:—"Body multiform, very porous, elastic, composed of a network of corneous fibres inosculating in every direction, and traversed by tortuous canals opening on the surface by wider orifices; the fibres often contain imbedded spicula: gelatine fugacious: marine." This series of characters would perhaps be sufficiently definite if we had to consider the British species of the *Spongiadæ* only, but when we launch into the wide field of exotic species, it ceases to be sufficiently descriptive and definite to enable us to hope to arrange these extraordinary and protean forms of animal life in such a manner as to allow the student to recognise a species, or to refer it to its proper genus with anything approaching to the same degree of certainty that we find the constant practice in the science of botany.

It is true that in the latter science we have a much more extended series of determinate structural characters than we can ever hope to find among the *Spongiadæ*, and that among plants these characters are of such a nature as to be readily available either to the unassisted vision or by the aid of a low microscopical power; while among the *Spongiadæ*, from the minuteness of many of the most essential organs, we can scarcely hope to make any great degree of progress in the knowledge and development of such characters without the aid of the best modern microscopical powers; but with such assistance there is little doubt in my own mind, from the great and permanent varieties of the structures of the skeleton especially, that we shall be enabled to establish such a series of well-defined new genera, and to subdivide and arrange those already established, as very materially to

lessen the now almost insuperable difficulty that exists under the present circumstances, in determining species by description. I therefore propose in the first place to limit the genus *Spongia* to such species only as strictly agree in the anatomical structure of the skeleton with the two well-known species of the sponge of commerce.

In January 1841* I had the honour of reading before the Microscopical Society of London, a paper "On the keratose or horny Sponges of commerce," in which I have proved the solidity of the fibre and the occurrence of spicula in certain portions of it; but at that time I had not been able to obtain the sight of a specimen of either the Mediterranean or West Indian species, in the precise condition in which they are, immediately after being taken from their native element. Since then I have been furnished by my friend Dr. Veronge with specimens of the West Indian sponges of commerce, which were undoubtedly alive when taken by him from the sea in the harbour at Bermuda, and some of which were immediately immersed in spirit to prevent the rapid discharge of the gelatinous interstitial matter.

In addition therefore to my former observations on these animals, I may state, that in a living condition the West Indian sponge is furnished with a thin, simple, and pellucid investing membrane, in which there is imbedded, without any definite arrangement, numerous simple single-pointed and simple double-pointed spicula, among which triradiate spicula are occasionally to be seen.

In one of the specimens obtained by my friend Dr. Veronge and preserved in spirit, the interstitial fleshy matter is very abundant and of a considerable degree of density. It abounds with siliceous simple single-pointed, simple double-pointed, triradiate and other forms of spicula agreeing precisely in character with those I have described in my paper published in the Microscopical Society's 'Transactions,' as occurring imbedded in the large flattened fibres of the sponge. There is no definite arrangement of these bodies, but they appear thickly and irregularly dispersed amid the gelatinous matter which fills up the whole of the interstices of the fibre, excepting those spaces which form the tortuous canals of the sponge.

With this additional information regarding their anatomical structure, I propose that the genus *Spongia* shall be limited to those species only which shall strictly agree with the well-known and legitimate types of the true *Spongiæ*, and that the following characters be adopted to limit and distinguish the members of the genus.

Gen. Char. Skeleton composed of a network of keratose fibres

* Transactions of the Microscopical Society, vol. i. p. 32.

inosculating in every direction without order. Fibre solid, cylindrical, without spicula, with the exception of a few large compressed fibres, which contain them in the centre. Investing membrane thin, pellucid and simple. Interstitial substance gelatinous, containing siliceous spicula.

There are many of the *Spongiadæ* which approach very closely to the true *Spongia* in the external appearance of the skeleton and in many of the prominent generic characters, but which nevertheless vary in their structural peculiarities in so marked and decided a manner as to render it advisable to arrange them in other genera, and foremost among these stands the group of which *Spongia fistularis*, Lamarck, is the type, and which I proposed in my former paper to make the type of a new genus, and to designate it *Fistularia*; but upon reconsideration I find, that although a most appropriate designation for the proposed genus, it has already been applied as a generic term in botany, so that it were better to abandon it altogether and to adopt another name, which, although it may not be so expressive of the leading character of the genus, will be more distinctive as regards other genera; and as I have been in a great measure indebted to my friend Dr. Veronge for a correct knowledge of this very interesting natural group of the *Spongiadæ* in the condition in which they exist in their native element, I shall be doing but an act of justice in commemorating his exertions in the cause of science by naming it in honour of him, and the following I propose as the characters of the genus

VERONGIA.

Gen. Char. Skeleton composed of a network of keratose fibres inosculating in every direction without order. Fibre cylindrical, continuously fistular, without spicula. Cavity of the fibre simple.

The external character of the fibre of this group is widely different from that of the great mass of the true *Spongia*. While in the latter they are usually flexible, fine in texture, and of a colour approaching to light amber; in the former, on the contrary, the fibre is rigid, coarse in texture, and very deeply coloured. The great central cavity of the fibre usually occupies about one-third of its diameter, but in some species it is of much larger dimensions. It is generally nearly uniform in its size in all parts of the same species, but occasionally it dilates considerably for a short space and then resumes its original diameter. It is also usually somewhat increased in its dimensions at the anastomosing portion of the fibre, as shown in Pl. XIII. fig. 7, which represents a piece of the fibre at one of the anastomosing points, seen with a power of 100 linear.

The great central cavity is lined with a thin pellucid mem-

brane, thickly overspread with minute semi-opake granules: such is its appearance in specimens which have been preserved in spirit immediately on being removed from the sea; but after having been dried, the membrane and its granulated coat is usually fractured in every direction, and then presents an appearance as if the cavity were lined with irregular, minute flocculent masses, or the membrane separating from the surface of the canal may be seen reposing in it in the form of a contracted tube. Portions of it may also be occasionally seen projecting from the fractured ends of the fibres, especially in the examinations of dried specimens.

I have been unable to detect any communication between the great central cavity and the outer surface of the fibre, the projecting ends of which are always naturally hermetically sealed.

I have been favoured by my friend Dr. Veronge with a very beautiful species of this genus which was immersed in spirit immediately on being removed from the sea. This specimen is in the form of a cluster of cylindrical tubes about twelve inches in height and two in diameter, the thickness of the tube being about half an inch.

The whole of the external and internal surface of the sponge is closely covered with a strong investing membrane, and I have observed the remains of a similar tissue upon several other dried species of this genus in my possession. In all the cases the membrane was simple in structure, semi-opake, and had the internal surface abundantly furnished with tessellated cellular structure.

The interstitial fleshy matter of the specimen presented to me by Dr. Veronge exhibits a high degree of organization. When a section was made at right angles to the axis of the sponge, it cut as firmly, and presented as close a texture as a section of the liver of a quadruped does.

When minute fragments were examined by transmitted light and a microscopic power of 300 linear, it was found to consist of closely compressed tessellated cellular structure, varying somewhat in its general aspect in different parts of the specimen, but in the best-defined portions it presented the appearance represented by Pl. XIII. fig. 8.

A few minute vessels were observed in the most transparent portions of this tissue meandering amid the cells, but in other species in which portions of the remains of the interstitial fleshy matter were found, they were observed to exist in a much greater abundance.

I have been unable to detect more than a few accidental spicula in the investing membrane of any of this family, and I believe that they do not naturally exist in any part of any one of the species of this group.

The *Verongiæ* have existed at former periods in great abun-

dance, as by far the larger number of the fossilized *Spongiadæ* are composed of this description of tissue, especially in the agates of the neighbourhood of Oberstein, and in the green agates, miscalled in commerce jaspers, from India. The boulder formation of the Yorkshire coast and the shingle of the Sussex coast also produce siliceous pebbles, containing perforated spongeous fibre in abundance, and I have similar specimens from various other localities.

In the fossilized state the remains of true *Spongia* are very much less common than those of *Verongia*, but this difference in their comparative numbers in this condition may possibly arise in some measure from the greater degree of strength and rigidity of the fibre of the latter tribe enabling them to resist the effects of accident and decomposition until they were imbedded in the silt of the ancient ocean and ultimately fossilized.

Auliskia.

Gen. Char. Skeleton composed of a network of keratose fibre. Fibre cylindrical, rigid, continuously fistular, having minute cæcoid canals radiating from it in every direction.

The external characters of the fibre of the skeletons of this genus are exceedingly like those of *Verongia*. The colour, the degree of rigidity and the mode of inosculation agree precisely with each other, and it is only when submitted to a careful microscopical examination by transmitted light with a power of 100 linear that the distinguishing character becomes apparent. Under these circumstances we find that the fibre is furnished with a continuous central canal as in *Verongia*; but in addition to this organ, which permeates every fibre of the skeleton, there are numerous minute cæcoid canals, radiating at irregular distances from all parts of the great central cavity, as represented by Pl. XIII. fig. 1. with a linear power of 100, and by figure 2 with a power of 300 linear.

These secondary canals are given off at nearly right angles to the great central one. They are very unequal in length, few, comparatively, reaching to near the external surface of the fibre, and none that I have been able to discover perforating it. The greater portion of them pursue nearly a straight line from the axis of the fibre, a few have a tortuous direction, and a still fewer number bifurcate or branch.

Within the great central canal there were frequently to be observed one or two long simple vessels, which might be seen traversing the cavity for a considerable distance, as represented in Plate XIII. fig. 1. *a* and *b*.

When there are more than one, as represented at *b*, they do not appear to unite, but run side by side until they reach one of

the anastomosing points of the fibre into which one of them will pass, while the other pursues the direct course of the great canal. They appear to be invested by a gelatinous coat or sheath, as seen at *c* in fig. 3, which represents a portion of the great central cavity of a fibre and its contents by transmitted light and a power of 800 linear. The cavity within the vessel is small compared with its external diameter, the parietes being so thick that it does not exceed a third or a fourth of the whole diameter, as represented by Pl. XIII. fig. 4. with a linear power of 1020.

I have never found a similar tissue in such a situation in any other recent sponge; but it is a remarkable circumstance, that the first indication of the existence of such vessels in the interior of sponge fibres was afforded me in the sponge tissues which abound in the moss agates of the neighbourhood of Oberstein, and which I have described and figured in a paper "On the Spongeous Origin of Moss Agates and other Siliceous Bodies," in the 'Annals and Magazine of Natural History' for September and October 1842.

The external surface of the fibre is frequently covered with a complex reticulated vascular tissue, a small portion of which is represented by Pl. XIII. fig. 5. with a power of 800 linear. It is probable, if the fibre were in its natural condition, that this tissue would be found to surround the whole of the fibrous skeleton.

A few minute portions of the remains of the fleshy interstitial substance were found adhering to some of the fibres. Upon immersing these in water, and submitting them to examination with a power of 300 linear, they proved to consist of a series of well-developed regular cells, represented by Pl. XIII. fig. 6. The parietes of the greater portion of them were thickly coated with deep amber-coloured, fleshy or gelatinous matter, and in some of them there was a large round or oval mass of the same description of substance, which in many cases nearly filled the whole of the interior of the cell.

It is much to be regretted that the specimen from which these details are drawn is but a fragment. It has evidently been part of a series of tubular bodies, cemented together by approximation, or of a series of tubular branches; the outer diameter of the tubes being about three-fourths of an inch, and the inner diameter about half an inch, so that the parietes do not exceed one-eighth of an inch in thickness.

Stematumenia.

Gen. Char. Skeleton composed of solid, compressed, keratose fibre, in which siliceous spicula and grains of sand are occa-

sionally imbedded. Interstitial substance fibro-membranous. Investing membrane simple.

S. scyphus. Sponge sessile; when immature massive, when adult cup-shaped; surface coriaceous, spinous. Excurrent oscula large, usually dispersed over the interior of the cup.

The fibres of the skeleton of the members of this genus are rigid when dry, but in a wet condition they possess a considerable degree of elasticity. The smaller ones are nearly cylindrical, and are usually without either spicula or grains of sand; but the larger and more mature fibres are considerably compressed, and have frequently grains of sand and spicula imbedded in the substance of the horny structure.

The most remarkable character in this tribe is the singular nature of the interstitial matter of the sponge, which is constructed of a beautiful interlacement of elongated fibres with little or no gelatinous substance intervening, as represented by Pl. XIV. fig. 1, and these are covered by others similarly disposed with their axes in a different direction, the mass being bound firmly together by other fibres running in tortuous directions so as to cement the whole into a membrane, as it were, of great strength and tenacity. Each fibre is of considerable length, but from their matted condition I have been unable to separate an unbroken one from the mass. They appear usually to have obtuse terminations without any attenuation towards the ends, but occasionally fibres are observed with large cytoblastic terminations, as represented by Pl. XIV. figs. 3 and 4.

The origin of this description of tissue appears to be similar to that of the sacculated tissue of *Cellepora pumicosa,* which I have described and figured in a paper "On the Organic Tissues in the Bony Structure of the Corallidæ," published in the 'Philosophical Transactions of the Royal Society,' part ii. 1844, p. 220, pl. 17. figs. 3 and 4, and also to the mode of the production of the primary vascular tissue in the new basement membrane of *Solen vagina,* described in a paper "On the Structure of the Shells of Molluscous and Conchiferous Animals," in the 'Transactions of the Microscopical Society of London,' vol. i. p. 144, and figured in pl. 18. fig. 4. *a* and *b*.

The fibres have usually a number of gelatinous-looking molecules, imbedded in the surface, which vary much in their size and form, as seen in Pl. XIV. fig. 5, which represents a portion of one of them examined by transmitted light with a linear power of 1020; and the cytoblastic terminations also are thickly studded with them, as represented in Pl. XIV. fig. 4.

This description of fibrous tissue is the more remarkable when we view its occurrence among the *Spongiadæ* in connexion with

its production in other and higher orders of the animal kingdom. Thus we find it in the foliated portions of a coral (*Pavonia lactuca*) when deprived of its earthy matter by dilute hydrochloric acid. In this case, the tissue occurs in the form of shorter and stouter filaments than in the sponge, and there is an attenuation of the fibre towards each of its ends; nor are the fibres so closely matted together as in the sponges, but on the contrary, there are frequently but a few filaments irregularly disposed amid the decalcified tissues of the coral. I have also found it in the remains of a fleshy mass of what appeared to be an Ascidian, which was attached to a group of zoophytes from Algoa Bay. It has also been shown, by Dr. Carpenter, that the decalcified shell of the common egg, and its *membrana putaminis*, are entirely composed of this peculiar tissue. In the latter instance the similarity is so great, both in the form of the structure and the mode of disposition, that it would be exceedingly difficult to distinguish between that derived from the sponge and the tissue of the *membrana putaminis*, if it were not that the fibres of the latter are somewhat less in diameter than those of the former.

The investing membrane is generally exceedingly thin and pellucid, and without any trace of fibres or other forms of organisation.

Cartilospongia.

Gen. Char. Fibre cartilaginous, imperforate, containing oat-shaped cavities thickly dispersed, from each of which numerous minute canals radiate to unequal distances.

C. rigida. Sponge free, compressed, discoid. Fibre rigid, compressed; longitudinal fibres radiating from the centre towards the circumference; lateral fibres at right angles to the longitudinal ones, forming square or oblong interstices. Excurrent canals, on the marginal edge of the sponge, few and irregularly disposed.

The general aspect of the fibre of this sponge is very like that of decalcified fœtal human bone from the cranium, but the fibre is somewhat more compressed.

When a few fibres, immersed in water, are examined by transmitted light with a power of 100 linear, it is seen that every part of their substance contains minute oat-shaped cavities, represented by Pl. XIV. fig. 7, and which correspond exactly, in form and mode of disposition, with the analogous minute cavities, miscalled corpuscles, which abound in such quantities, and are so well known to every anatomist as peculiarly characteristic of true animal bone. In the latter, when viewed with a high microscopic power, there may be observed a profusion of exceedingly minute radiating canals, which are said to communicate with the

Haversian canals. In the sponge, these minute radiating canals are also present, but they are much fewer in number, and require a power of 1000 linear to render them distinctly apparent. Under these circumstances they are seen, as represented in Pl. XIV. fig. 6, radiating from the oat-shaped cavities, and usually decreasing in diameter until they terminate at unequal distances from the parent cavity, in exceedingly minute points. In many cases, the commencement of these minute canals is expanded in the form of a funnel, so as beneath a power of about 500 linear to cause the oat-shaped cavities to appear fringed with a series of projecting points.

The surface of the fibre is covered with nucleated cytoblasts and tessellated cellular structure in various stages of development, and in the centre of some of the more fully-developed of these cells, in place of their being entirely filled up by the secretion of cartilaginous matter, there is frequently an elongated cavity remaining, which probably becomes one of these peculiar organs, after having been immersed in the cartilaginous substance of the fibre by successive layers of cellular structure. Occasionally, but by no means frequently, there are small patches of ramifying canals situated immediately beneath the surface of the fibre, as represented at Pl. XIV. fig. 7 *a*, as seen with a linear power of 100. It is difficult to imagine what office these canals perform in the œconomy of the animal, as they do not appear with the same degree of constancy or regularity as in other sponges where similar tissues occur in like situations.

In some of the expanded portions of the fibre, there are often small round or oval holes, and around these the oat-shaped cavities are arranged in a series of concentric rings, exactly representing the mode of arrangement of the corresponding organs in true bone, in the vicinity of the Haversian canals.

It is much to be regretted that there are no remains whatever of spicula or of fleshy interstitial substance to be found in this interesting specimen, nor am I aware of the part of the world of which it is a native, as it was procured from a dealer in natural curiosities, who could afford no clue to its previous history. The specific characters, therefore, must be considered as provisionally given, until other specimens may be found from which fuller and better characters may be established.

The form of the sponge is that of a thick disc, the diameter being five and a quarter inches, and the thickness, one inch and three quarters. The two broad surfaces correspond exactly in form and structure; a portion of one of them is represented by Pl. XIV. fig. 8.

There is no appearance, at any part of the sponge, of a point of attachment or base.

The fibre in the dry state is exceedingly rigid and brittle, and preserves much of its rigidity even after having been soaked many hours in water. The radiation of the fibres from the centre of the sponge towards the outer surface is in a series of straight lines, and the interstices rarely exceed half a line in length.

The great excurrent canals are found only on the extreme edge of the sponge; they are few in number, and are disposed in a single line at unequal distances throughout the whole of the circumference of the sponge, the largest not exceeding two lines in diameter.

This sponge is remarkable for its approximation, in the structure of its skeleton, to the highest orders of animal organization.

BIBLIOGRAPHICAL NOTICES.

A History of the British Freshwater Algæ, including descriptions of the Desmideæ *and* Diatomaceæ, *with upwards of* 100 *Plates.* By A. H. Hassall, F.L.S. 2 vols. 8vo. London, 1845.

We consider the publication of this work as likely to promote in a great degree the study of the freshwater Algæ of Britain; a tribe which, owing to its great obscurity and the want of good magnified figures, has been almost universally neglected by our botanists. Whilst the Mosses, the Lichens, the Fungi, and even the marine Algæ have had valuable and elaborate works devoted to their elucidation, we are not acquainted with any extensive English work on the freshwater tribes since that of Dillwyn, which, although highly valuable, having appeared before the structure of the Algæ was much understood, cannot be considered as supplying the deficiency. The figures contained in Mr. Hassall's work will be found of the utmost value to the student of this curious tribe of plants, as they appear in most cases to have been carefully drawn and to be faithful representations of the species. It is unfortunate that the author has not pointed out the cases in which his figures are not the result of his own observations, but copied from published plates. The appearance of "*Hass. delt.*" at the bottom of all the plates leads us to suppose that they are all of them original, but a more careful examination shows that not a few are copies. We shall notice some of these as we proceed, previously however reminding our readers that the parts of the book which it falls to our lot to blame are only a small portion of the whole. As a whole, there can be no doubt that it is a proof of its author being possessed of very considerable abilities; more especially of extensive powers of discrimination, although not of definition. We consider these powers as quite distinct and frequently existing separately, although both are essential to a writer on descriptive natural history.

In the preface we find it stated that "the characters developed in the state of reproduction are relied upon in the framing not merely of the families and genera, but also in the definition of species" in the