than the corresponding bone in any living Monotreme), whereof I beg to enclose drawings; the bone is seen from three different points of view,—to which are added sketches of the same part of an *Echidna hystrix* slightly enlarged. They may be figured, however, of the same size as the sketch, because I have before me the articulated skeleton of an *Echidna* in which the humerus is fully as large. The fragment in the possession of the trustees of this Institution is a portion of the distal part of this bone; the articulating surface, which fits into the sigmoid cavity of the ulna, is perfect; and, from its peculiar structure, it cannot well be mistaken for that of any other known mammal.

I have not yet seen any of the papers lately published by Professor Owen on Australian fossil remains; and as it is possible that a fossil *Echidna* is already described, I do not wish to name the present species; otherwise I should propose the specific term of *E. Owenii* for it.

I have the honour to be,
Gentlemen,
Your very obedient Servant,
GERARD KREFFT.

Australian Museum, Sydney.
November 23, 1867.

XX.—*On the "Vitreous" Sponges.* By Professor WYVILLE THOMSON, LL.D., F.R.S.E., F.G.S., M.R.I.A.

[Plate IV.]

THE classification of the PORIFERA is as yet extremely unsatisfactory. This arises chiefly from the circumstance that the essential part of a Sponge, the sarcode sheet investing the supporting framework, presents no visible distinctive characters, being apparently nearly the same in physical properties and in chemical composition throughout the whole series. Characters must therefore be founded upon accessory and comparatively unimportant parts; and these exhibit, with few exceptions, so finely graduated a series of minute variations that it is difficult to employ them in the definition of orders and suborders. Except in a few cases, but little stress can be placed upon the external form of the sponge-mass, even as a specific character. Often the general appearance of a sponge is characteristic enough, and a practised eye can easily recognize it in almost all its stages of growth; but it is impossible to embody the impressions on which this recognition is based in a description, or even to convey them by the most accurate figures. Hence the extreme difficulty in naming a collection

of Sponges from monographs and memoirs in which external form is chiefly considered, such as the beautiful work of MM. Duchassaing and Michelotti, and Johnston's 'British Sponges.'

The microscopic characters of Sponges, derived from the structure and form of the reticulated supports, and from the special forms of the spicules, are usually well marked; but these characters are in most cases of specific, in a few of generic, and in scarcely any of ordinal value. Fortunately, the chemical composition of the organs of support and of defence, two or three well-defined general types of structure and form of the spicules, and the general arrangement and mode of combination of the different parts, present some good points of distinction for larger groups.

I think that certainly the most satisfactory arrangement of Sponges is that proposed by Dr. Oscar Schmidt*. Dr. Schmidt's memoir, however, labours under the disadvantage of dealing with the Sponges of the Adriatic only; so that many remarkable exotic forms, which might have modified to some extent his ideas of classification, are excluded. In the second Supplement, indeed, the author institutes a comparison between the Adriatic Sponges and those described by Dr. Bowerbank; but the series is still incomplete, from the absence of illustration from the rich faunæ of the East and West Indies.

Dr. Schmidt divides the Adriatic Sponges into six groups, of the rank of families†. The first of these are the **Calcispongiæ**, which he thus defines:—"Spongiæ parvæ, plerumque albicantes, corpore spiculis calcareis pertexto."

It seems to be generally admitted that the Sponges with calcareous spicules are essentially distinct; and I am inclined to agree with Dr. Gray‡, who places them in a distinct subclass, antithetic to the whole of the remainder of the Sponges, which form in his arrangement a second subclass under the name of Poriphora Silicea.

There is an evident awkwardness in placing such genera as *Spongia* and *Halisarca* (in which there is no silica whatever in any separate form) among the siliceous Sponges; still I think the classification is justifiable; and it is at all events convenient. The true horn Sponges pass by almost imperceptible gradations into the groups which develope distinct siliceous elements, either within the fibres (e. g. *Chalina*) or

* 'Die Spongien des Adriatischen Meeres,' Leipsic, 1862 (and two Supplements).

† Handbuch der vergleichenden Anatomie. Jena, 1865.

‡ "Notes on the Arrangement of Sponges," Proc. Zool. Soc. Lond. May 9, 1867.

among their meshes (*Diplodemia* &c.); so that I believe we may regard the whole group as potentially siliceous.

Dr. Schmidt's second family are the **Ceraospongiæ**:—"Spongiæ quarum sceletum formatur fibris solidioribus, recenti statu plus minusve elasticis, quæ sæpius aliena corpuscula involvunt, sed nunquam spicula in ipsis nata continent."

His third family are the **Gummineæ**:—"Spongiæ *Corneospongiis* proximæ. Parenchyma spississimum et maxime compactum, adspectu Kautschuk, quod tamen fibrillis tenuissimis contextum est. Generum pars corpuscula silicea continent."

The fifth family in Dr. Schmidt's arrangement are the **Halichondriæ**:—"Spongiæ spiculis siliceis pertextæ, quæ ob telam laxiorem et minus spissam quamquam sæpius subcorneam neque *Gummineis* adnumerantur, neque *Corticatis* ob defectum strati corticalis."

The careful consideration of the diagnoses of these three groups is quite as suggestive as the examination of an extended series of the Sponges themselves, of a single graduated line of forms in which there are no breaks of sufficient importance to justify its subdivision into groups of higher value than families.

The horn Sponges and the Gummineæ are so nearly allied that they can be distinguished by comparative characters only. The fibres of the horn Sponges are thicker, and the meshes wider, the whole texture is more open than in the Gummineæ, in which the minute fibres are matted together in the consistent sarcode, and the Sponge, when dried, looks like a piece of leather. The general aspects of the two groups are very distinct; and even to the inexperienced eye the Gummineæ form a natural and easily recognizable series, whose characters it is, however, scarcely possible to reduce to an intelligible definition. From the absence of positive characters, it is evident that these two groups are liable at any point to pass into one another. Among the Gummineæ separate siliceous spicules appear in abundance, the fibrillation of the horny matter becomes obscure; and we thus pass almost imperceptibly into the fifth group, the Halichondriæ.

Professor Schmidt's fourth group are the **Corticatæ**:—"Spongiæ globosæ vel tuberosæ; spiculis siliceis pertextæ, peculiari strato corticali circumdatæ, quod et tela organica firmiori fibrillosa et plerumque corpusculorum siliceorum genere a parenchymate interiori differt."

In this group we have positive characters of some value in the very marked difference between the cortical layer and the central mass, in the regular arrangement of the various histiological elements, and in the peculiar type of the defensive

spicules, where these occur. I am inclined to regard the corticate group, as limited by Prof. Schmidt, as of ordinal value.

Prof. Schmidt's last family are the **Halisarcinæ**:—"Spongiæ molles, non fibrosæ, corpuscula calcarea vel silicea non continentes"—equivalent to the Halisarcina of Lieberkühn, an obscure group with neither horny fibres nor siliceous spicules, and consisting of little more than an extended sheet of sarcode.

The definitions of the three orders in Dr. Bowerbank's 'British Spongiadæ' are sufficiently simple; but I cannot regard the "KERATOSA" as a group equivalent to the "CALCAREA" and the "SILICEA."

The diagnoses of the suborders are based upon some important modifications in the arrangement of the spicules and horny matter, which do not, however, seem to be sufficiently definite for the purposes of classification. The groups are, on the whole, natural.

Admitting the value of Dr. Gray's two primary subclasses, the details of his classification seem to me unsatisfactory. The author divides the Siliceous Sponges into two primary groups —(1) those with membranous or unarmed ovisacs, and (2) those whose ovisacs are strengthened with siliceous spicules. I doubt if we know enough of the nature of these peculiar bodies which we for the present call ovisacs, to found upon them broad distinctive characters. The present attempt to do so separates to the utmost the nearly allied corticate genera *Tethya* and *Geodia*, and places *Spongilla* and *Halichondria* (*Isodictyon*) (between which, except in the one point of the structure of the "ovisacs," it is difficult to define generic distinctions) in different principal sections. Under the first two subsections of the MALACOSPORÆ, *Dactylocalyx* and *Spongia* are associated, on account of the common character of possessing a network, while *Aphrocallistes* is divorced from its beautiful partner *Euplectella*. The third subsection, the ARENOSPONGIÆ, is an excellent group, apparently of ordinal value.

Subordinate to the subsections, Dr. Gray proposes seven orders and a host of genera, and very naturally anticipates the general denunciation of a system which complicates the nomenclature to bewilderment, and founds generic groups upon such "imperfect materials" as a "bihamate spicule figured in Bowerbank's 'British Sponges.'"

The only classification which has any material advantage over the older classifications of Nardo, De Blainville, Johnston, and Lieberkühn, seems to be that of Dr. Oscar Schmidt. Duchassaing and Michelotti, Bowerbank and Gray, have each made valuable individual suggestions; but Dr. Schmidt's grouping, taken as a whole, appears to be the most in accordance with our knowledge of the anatomy and physiology of the class.

I believe we are now in a position to define another order, equal in value to the CORTICATA and the HALICHONDRIDA; and for this new order I would propose the term (Porifera) VITREA.

The following is an outline of the slight modifications which I would suggest in Dr. Schmidt's arrangement:—

Class PORIFERA, Grant.

Subclass I. (Porifera) CALCAREA, Bowerbank. "Skeleton composed of calcareous spicules which are generally three-rayed stellate" (Gray), equivalent to Dr. Schmidt's first family. Ex. *Grantia*, *Sycon*.

Subclass II. (Porifera) SILICEA, Gray. "Sponges provided with a siliceous or horny skeleton, or with a horny skeleton strengthened with siliceous spicules."

Order 1. (P. Silicea) VITREA. Sarcode in small quantity, very soft; never containing formed horny matter, either fibrous, membranous, or granular. The skeleton consists entirely of siliceous spicules, either separate (in fascicles or scattered) or anastomosing and combined into a continuous siliceous network. The sarcode contains small spicules of a different character from the general spicules of the skeleton, and of complicated forms. The spicules, whether of the skeleton or of the sarcode, may all be referred to the hexradiate stellate type. Ex. *Hyalonema*, *Dactylocalyx*.

Order 2. (P. Silicea) HALICHONDRIDA. Tuberous, branching, cup-shaped, irregular, or incrusting; without any definite external cortical layer. The sarcode is abundant, consistent, and in all cases is supported by a greater or less amount of formed horny matter, which is fibrous, granular and diffused, or in the form of more or less distinct membranous expansions. The sponge usually contains an abundance of siliceous spicules variously arranged.

Suborder 1. (Halichondrida) HALICHONDRINA (Lieberkühn). Sarcode abundant, usually consistent. The horny matter granular or membranous, but never in the form of a network of solid horny fibres. Skeleton consisting mainly of siliceous spicules, which are usually essentially of the same form in all parts of the sponge. In one family, the Esperiadæ, the sarcode is soft, and the spicules are of two distinct types. Ex. *Halichondria*, *Spongilla*, *Esperia*.

Suborder 2. (Halichondrida) GUMMININA (= Gummineæ, Oscar Schmidt). Sponge-substance compact; skeleton of fine densely interwoven horny fibres. Siliceous spicules in some of the genera. Ex. *Gummina*, *Corticium*.

Suborder 3. (Halichondrida) SPONGINA (Lieberkühn). Skeleton an elastic wide-meshed network of anastomosing horny fibres, frequently containing foreign bodies, such as grains of sand and spicules of other sponges, and occasionally siliceous spicules developed within them, and never associated with free siliceous spicules in the sponge-mass. Ex. *Spongia*, *Chalina*, *Dysidea*, &c.

Order 3. (P. Silicea) CORTICATA (O. Schmidt). Globular, tuberous, or branched Sponges, supported by regular radiating sheaves of long siliceous spicules, and invested with a special dense cortical layer, often containing spicules of special and characteristic forms. Ex. *Tethya*, *Geodia*, *Placospongia*.

Order 4. (P. Silicea) ARENOSA (= Arenospongia, Gray). "Sponge consisting of a disk of agglutinated sand, with a series of diverging spicules on the circumference of the disk, and a pencil of similar spicules at the mouth of the oscules on the upper surface of the disk." (Gray, *l. c.*) Ex. *Xenospongia*.

Order 5. (P. Silicea) HALISARCINA (Lieberkühn). Sponge an extended sheet of sarcode, destitute of either siliceous or horny support. Ex. *Halisarca*.

My principal object in the present communication is to define the first of the siliceous orders, the glassy Sponges. I believe the following to be the scope of the group in known genera and species:—

Order I. (Porifera Silicea) VITREA.
- Genus 1. HABRODICTYON*, n. g.
  - *H. speciosum*, Quoy & Gaimard (sp.).
  - *H. corbicula*, Valenciennes (sp.).
- Genus 2. HYALONEMA, Gray (in part).
  - *H. Sieboldi*, Gray.
  - *H. lusitanicum*, Gray.
- Genus 3. EUPLECTELLA, Owen.
  - *E. aspergillum*, Owen†.
- Genus 4. APHROCALLISTES, Gray.
  - *A. beatrix*, Gray.
- Genus 5. DACTYLOCALYX, Stutchbury.
  - *D. pumicea*, Stutchb.
  - *D. subglobosa*, Gray.
  - *D. Prattii*, Bowerbank.
  - *D. callocyathes*, Gray (sp.).
  - *D. azorica*, Gray (sp.).
  - *D.? torva*, Duchass. & Michelotti (sp.).
- Genus 6. FARREA, Bowerbank.
  - *F. occa*, Bowerbank.

* ἁβρὸς, *delicate*, and δίκτυον, *a net*.

† Through the kindness of Dr. Farre, I have had an opportunity of see-

—an assemblage of the most beautiful, the most singular, and the rarest of marine productions.

General Characters of the Group.

Condition of the Sarcode.

From its essential simplicity and the want of any true structure, the sarcode of the glassy Sponges cannot be expected to afford any very marked distinctions; still even this element seems to differ in certain characters from the condition in which we find it in the other orders of Sponges. It is small in quantity, very soft, probably semifluid, extending in a thin layer over the fascicles of siliceous needles and over the siliceous framework. It appears to contain no trace of the diffused granular horny matter with which the more consistent sarcode of the Halichondrida is so often loaded. When a vitreous Sponge is dried (and all the specimens which have yet reached Europe are in a dry state), the whiteness of the skeleton is barely masked by the pale yellow film which represents the contracted animal matter. Most of the specimens of *Euplectella* in the market have been bleached; but some of them, which may be recognized by their pale fawn-colour, are merely dried; and if a portion of one of these be steeped for a short time in a warm weak solution of caustic soda, the sarcode softens and expands, and may be examined under the microscope with tolerable success. It is generally almost transparent, with here and there scattered endoplasts and minute compound granular masses. Among the meshes of the sponge-network, and everywhere except where it is extended (as in *Hyalonema* and *Euplectella*) over the surface of enormously long separate needles, the sarcode contains abundance of extremely minute spicules, scattered through it singly or aggregated in groups. These spicules, as we shall see hereafter, are often complicated in form and ornament, and are highly characteristic of the order and of the several genera.

The Siliceous Skeleton.

In *Habrodictyon* and *Hyalonema* the skeleton is composed entirely of separate siliceous spicules of various forms, interwoven in fascicles and connected by the thin sarcode layer, or scattered irregularly among the fascicles of spicules. In *Euplectella*, *Aphrocallistes*, *Dactylocalyx*, and *Farrea*, certain

ing his lovely specimen, upon which Professor Owen founded the species *Euplectella cucumer*. I can have no doubt that this is merely an example of *E. aspergillum* of a rather unusual form, which has attained its full size, but in which the raised spiral crests are as yet imperfectly developed.

kinds of these spicules are more or less completely fused together, forming a continuous anastomosing network.

Two forms of free spicules are extremely abundant throughout the group. The first are simply fusiform, frequently slightly curved, and often enlarged and tuberculated or otherwise armed or ornamented at one or both ends. These spicules vary greatly in length—from ·05 to ·5 of an inch in the skeletons of *Habrodictyon* and of the sponge-mass of *Dictyonema*, where they are grouped in fascicles and make up the greater part of the flexible network, to 3 or 4 inches in the silky fringe at the base of *Euplectella*, and to the enormous length of from 18 to 20 inches in the wonderful vertical wisp which is popularly known as the "glass rope" of *Hyalonema*.

These spicules have all essentially the same structure; they consist of extremely thin concentric layers of silica separated by films of sarcode, and are traversed throughout their entire length by a delicate canal, occupied in the fresh state by a sarcode axis.

The second form is called by Dr. Bowerbank "cylindro-rectangulated hexradiate" (British Sponges, vol. i. figs. 185, 186). It consists of a central shaft with the ends often spined or tuberculated as in the fusiform spicules. Near the middle of the shaft four secondary branches, at right angles to one another, form a cross, the radii at right angles to the axis of the shaft. The central canal is very distinct in the main axis, and sends branches into the four diverging radii. Rarely only two secondary branches are produced, but this is evidently by suppression. These spicules are large, sometimes ·05 inch in length. They are scattered irregularly among the fusiform spicules in *Habrodictyon*, *Euplectella*, and *Hyalonema*, and are sometimes aggregated in groups.

The fusiform and the hexradiate spicules are modifications of one type. About the middle of one of the fusiform spicules, whether it be taken from the coil of *Hyalonema*, from the fringe of *Euplectella*, or from the general skeleton of any vitreous Sponge, if we use sufficient care and a sufficient magnifying-power, we can always detect one or two fine cross canals cutting the axial canal at right angles. When the cross canals have an appreciable length, two or four slight bulgings on the outer surface of the needle indicate their position (Pl. IV. fig. 1 *c*). It is remarkable that this hexradiate type of spicule, which is so abundant in the vitreous Sponges, is unknown in any other order.

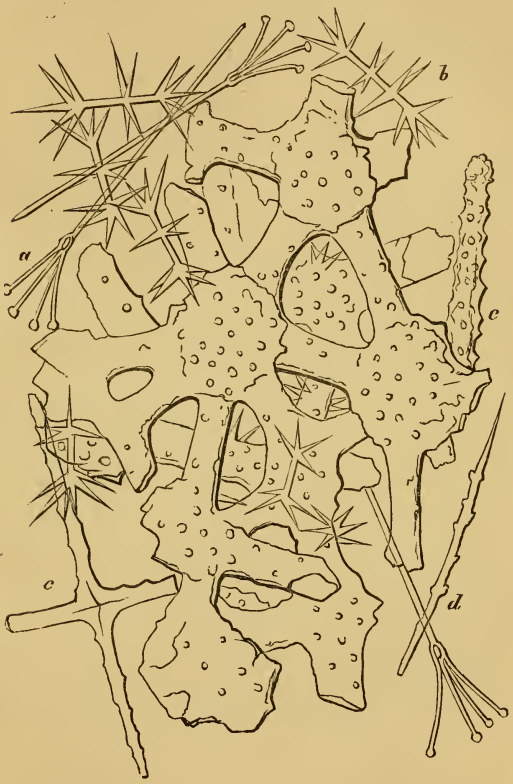
In *Hyalonema* the hexradiate spicules of the second form are usually if not always perfect and symmetrical. In *Habrodictyon* they are very frequently distorted, the rays twisted, and in

many cases several are partially united together. In *Euplectella* perfect and distorted spicules of this class are entangled in the loose meshes of a framework which is evidently formed by the still further distortion and anastomosis of spicules of the same type. In *Aphrocallistes* (see woodcut) the network is still more evidently produced by the coalescence of stellate spicules, though their hexradiate character is somewhat obscured. In the network of *Farrea* (Bowerbank, Brit. Spong. vol. i. fig. 277) the hexradiate type is very marked. The primary axis of the spicule is reduced to a conical tuberculated spine; and spines of exactly the same form are developed in a corresponding position on the outer surface of *Aphrocallistes* (woodcut, *e*). In *Farrea* the spicules are distinctly tubular; but this is merely a question of degree. In *Dactylocalyx* the reticulation has become very irregular; but I have no doubt, from the style of netting (see Bowerb. Brit. Spong. vol. i. fig. 275) and from the close analogy in other respects between this genus and *Aphrocallistes* and *Farrea*, that its fundamental plan is the same.

I believe that it would be safe to accept the generalization that the continuous siliceous network, wherever it occurs in the vitreous Sponges, is produced by the fusion of spicules of the hexradiate type.

Throughout the whole order the spicules of the sarcode are very abundant, and are often very elegant in form. They are extremely minute, usually not more than ·001 of an inch in length or diameter, and are seen adhering in groups to the larger spicules, or entangled in multitudes among the fascicles and in the meshes of the sponge. However complex these spicules may finally become, they all, with perhaps one doubtful exception—the bihamate spicule figured by Bowerbank as from *Farrea occa* (Brit. Spong. vol. i. fig. 114)—may evidently be referred to the hexradiate type. In both species of *Habrodictyon* the most common sarcode-spicule is the "floricomo-hexradiate" of Bowerbank (Pl. IV. fig. 1 *e*); and the same form occurs abundantly in *Euplectella aspergillum*. The "coronato-hexradiate stellate" form figured by Bowerbank (Brit. Spong. vol. i. fig. 195) seems to be the central star of one of these without the curved processes. Associated with this type, we have in *Habrodictyon* multitudes of extremely minute hexradiate spicules, variously armed and feathered, and scarcely distinguishable from the ordinary spicules of the sarcode of *Hyalonema*. The spicule which in the series departs most from the hexradiate form is the wonderful double grapnel of *Hyalonema*; but, although its ends are split up into curving flukes, in the very middle of the shaft the cross-canals

betray the universal type. One set of the sarcode-spicules of *Aphrocallistes* is almost identical with the "furcated spiculated biternate" spicule figured from *Farrea occa* (British Sponges,



vol. i. fig. 199), but more spiny. I am afraid to name this form; but I am sure it would be highly suggestive to Dr. Bowerbank.

Another set from *Aphrocallistes* are especially interesting (woodcut, *a*): they consist of a lengthened shaft ending in a small expansion, from which spring four equal branches, each terminated by a little knob. No doubt these are the separated branches of a complex hexradiate spicule closely resembling those figured by Bowerbank (British Sponges, vol. i. figs. 190–192) from species of the penultimate genus of our series, *Dactylocalyx*.

General Structure of the Sponges.

The netted walls of the two species of *Habrodictyon* are formed of a loose open network of fascicles of comparatively short fusiform spicules, the fascicles loosely bound together by the soft sarcode. The bundles curve irregularly in all directions, so that the network is quite irregular. No distinct bundles of long fibres pass longitudinally from end to end of the sponge, or transversely round it as in *Euplectella*. In *H. corbicula* the upper truncated end of the tube is closed by a netted lid, of a denser aggregation of spicules than that which forms the general wall; while in *H. speciosum* the general wall extends uniformly over the enlarged end of the tube without any change of structure.

The spongy portion at the base of *Hyalonema* resembles closely in minute structure the wall of *Habrodictyon*. The spicules are nearly of the same form, and are arranged much in the same way; but the bundles of needles are meshed into a porous conical mass whose parts tend to radiate towards, to be combined with, and to support a bundle of enormous spicules, whose lower portion is twisted into a close, compact, tapering coil in the centre of the sponge, while the upper part of the coil projects a foot above the centre of the sponge, and is frayed out in the water like a glittering brush of glass*.

In *Euplectella*, the long vertical spicules, instead of forming an isolated wisp as in *Hyalonema*, are separated into small fascicles, which are spread out symmetrically and connected into a netted tube by ring-like bundles of transverse fibres. The result is a wonderfully beautiful and symmetrical net with square meshes. Over this framework the general sponge-

* I have not space at present to discuss the curious diversity of opinion which exists as to the relations of *Hyalonema*. I will only refer the reader to an admirable memoir by Professor Max Schultze, 'Die Hyalonemen,' Bonn, 1860, to a second paper by the same author in the 'Annals and Magazine of Natural History,' March 1867, and to a paper of my own in the 'Intellectual Observer' of the same date.

substance, composed mainly of a siliceous tubing formed essentially by the coalescence of spicules of the hexradiate type in every condition of distortion, is regularly spread, partially closing and reducing to rounded pores, by an oblique tissue of interlacing threads, the square meshes of the frame, and rising on the surface of the sponge into irregular spiral ridges.

The mouth of the tube is closed, as in *Habrodictyon corbicula*, by a netted lid of dense tissue. Not taking into account differences in the form of the spicules, of specific value only—if the siliceous coil of *Hyalonema* were separated into small bundles and attached by transverse fibres within the wall of the tube of *Habrodictyon*, we should have a Sponge which would be referred without doubt to the genus *Euplectella*.

Aphrocallistes is very nearly allied to *Euplectella*. There are the same fascicles of longitudinal fibres within the tube, and there is the same netted lid; but the tube is irregular in form, and the siliceous network is much more dense and compact. It will be remembered that some of the spicules of the sarcode in *Aphrocallistes* resemble those in *Farrea*, while others correspond with the form hitherto only known in *Dactylocalyx**. In *Dactylocalyx* the longitudinal fascicles have disappeared, and the siliceous network is much more dense and irregular. A specimen from Barbadoes, which I saw in the Paris Exhibition, had almost the cylindrical form of *Aphrocallistes*; an example in the Belfast Museum is cup-shaped and looks like a silicified bath-sponge. I hope to have an opportunity of revising the whole of this genus or group of genera on some future occasion. The ultimate structure of its siliceous network and the close resemblance in form of its sarcode-spicules associate *Dactylocalyx* clearly with *Aphrocallistes* and *Farrea*.

Farrea is undoubtedly a vitreous Sponge allied to *Aphrocallistes*. The hexradiate type of the framework, and the spicules figured by Dr. Bowerbank (Brit. Spong. figs. 199, 200), are very characteristic. I am in doubt about the bihamate spicule (*ibid.* fig. 114). From the condition of the only known example of *Farrea occa*, I should think it possible that one or many spicules of that form may have been mixed with it, possibly from some associated species of *Esperia*.

Relations of the Group.

It is difficult even to speculate upon the position of the vitreous Sponges in the series of the Porifera. There is

* I am indebted to my friend Dr. Gray for an opportunity of examining the minute structure of *Aphrocallistes*. The woodcut represents a fragment of the general network of the wall of the tube, with some of the characteristic spicules of the sarcode alluded to above.

something in the wonderful complexity of design and profusion of ornament in the siliceous skeleton which reminds one strongly of the POLYCYSTINA; and even, in some cases, the special forms of the spicules are repeated in the two groups. (Compare pl. 12. fig. 1, pl. 17. fig. 4, pl. 18. fig. 15, pl. 21. fig. 7, pl. 32. figs. 10, 11, pl. 33. figs. 6, 7, &c. of Haeckel's 'Die Radiolarien'). As yet, we know nothing of any of the species in a living state. The sarcode is certainly somewhat different in character from that of the other groups of Sponges, —softer and more mobile, less loaded with granular formed matter, and more transparent. For sarcode in this condition we should be inclined to anticipate a somewhat higher form of vital activity. It remains to be seen whether there may be any approach by the extension of any form of pseudopodial processes to the condition of the sarcode in the RHIZOPODA. Under a strong impression that it is through this order that the Sponges pass into the RADIOLARIA, I have placed the PORIFERA VITREA at the head of the series of siliceous Sponges, beginning with those genera in which the siliceous elements are most independent and varied, and the sarcode least consistent. I believe that Dr. Gray has rightly indicated the base of the order by placing the Flower-baskets next the Esperiadæ, which I should certainly regard as the inosculating family of the HALICHONDRIDA.

(Porifera Silicea). Order I. VITREA.

HABRODICTYON, n. g.

1. *Alcyoncellum*, De Blainville, Quoy & Gaimard, 'Voyage de l'Astrolabe,' Zoologie, vol. iv. p. 302. Paris, 1833.
2. *Alcyoncellum*, Deshayes and Milne-Edwards, in Lamarck's 'Animaux sans Vertèbres,' vol. ii. p. 589 (1836).
3. *Alcyonellum*, Owen (misprint for *Alcyoncellum*), Trans. Zool. Soc. vol. iii. p. 205 (1849).
4. *Alcyoncellum*, Bowerbank, Phil. Trans. and British Spongiadæ, vol. i. p. 174 (1865).
5. *Euplectella*, Gray, Ann. & Mag. Nat. Hist. vol. xviii. p. 487 (1866).
6. *Corbitella*, Gray, Proc. Zool. Soc. for 1867, p. 530.
7. *Heterotella*, Gray, Proc. Zool. Soc. for 1867, p. 531.

Sponge-body subcylindrical, tubular, attached by a slightly contracted base. The walls of the tube composed of a perfectly irregular network of bundles of siliceous needles loosely and irregularly arranged in sheaves crossing one another at low angles, and connected by a small quantity of soft mucilaginous sarcode. The spicules of the skeleton all essentially of the hexradiate form, free and separate from one another, or rarely connected in groups of two or three. The spicules of the sarcode very numerous, "floricomo-

hexradiate stellate," and various simple and branched modifications of the hexradiate type.

There seems to be something unusually fatal in the fascinations of these beauties. As to *Habrodictyon speciosum*, it certainly seems almost "useless to continue to quote the singular number of errors into which" every one appears to have "fallen in the description of this beautiful Sponge." Professor Owen, of whom this was first said, has certainly gone least astray, as he has succeeded thoroughly in the object which he had in view at the time, by giving us a description of *Euplectella aspergillum* which, if we combine with it that of *E. cucumer*, can scarcely be surpassed.

1. The use of the name *Alcyoncellum* by Messrs. Quoy and Gaimard, and the quotation of De Blainville's diagnosis of the genus, is clearly a *mistake*, arising from some confusion of the papers on the part of the compilers of this work. "Genre Alcyoncelle (*Alcyoncellum*). Corps phytoïde, subpierreux, solidifié par des spicules tricuspides; à branches peu nombreuses, cylindriques; fistulaire, terminé par un orifice arrondi, à parois épaisses composées de granules réguliers, polygones, alvéoliformes, percées d'un pore à l'extérieur et à l'intérieur. *Alcyoncellum speciosum*, nob., pl. 26. fig. 3. Alcyoncellum cylindricum, cavum, extremitate rotundum, album, reticulis lapidicis elegantissime contextum." The specific description does not in any way correspond with the diagnosis of the genus.

2. M. Milne-Edwards ignores altogether De Blainville's description, and refers the generic name *Alcyoncellum* to Quoy and Gaimard. He adds a fair description of the genus:— "MM. Quoy et Gaimard ont donné le nom *Alcyoncelle* à un corps qui paraît appartenir à la famille des Spongiaires, et qui présente une structure très-remarquable; on peut assigner au genre dont ce zoophyte est le type les caractères suivans:— Genre *Alcyoncelle* (*Alcyoncellum*). Spongiaire lamelleux dont la charpente est formée de filets très-déliés, accolés les uns aux autres, et entrecroisés de manière à former des mailles nombreuses, arrondies, assez régulières et semblables a celles d'une dentelle. On ne connaît qu'une espèce d'*Alcyoncelle*, qui est très-remarquable par sa beauté et qui a été rapportée des Molluques par MM. Quoy et Gaimard, elle a la forme d'un panier profond et étroit dont les parois seraient composées d'un tissu délicat d'un travail analogue à celui des siéges à rotang dont les modèles nous viennent de l'Inde. Ces naturalistes lui ont donné le nom de *Alcyoncelle specieux* (Quoy et Gaimard, Voyage de l'Astrolabe)."

3. Professor Owen recognizes, apparently from the figure in the 'Voyage de l'Astrolabe,' the generic distinctness of *Habrodictyon* from *Euplectella*. He gets into confusion, however, about the synonymy. "If the basal aperture of the cone were open, the resemblance to some of the known reticulate Alcyonoid Sponges would be very close, especially to that called *Alcyonellum gelatinosum* by M. de Blainville (*Alcyonellum speciosum*, Quoy & Gaimard); its closure by the reticulate, convex frilled cap in the present instance establishes the generic distinction."

4. Dr. Bowerbank's references and remarks are curiously inaccurate: Dr. Gray has, however, already done them full justice at the close of a short paper in the 'Annals' for 1866, except in one point. Dr. Bowerbank's definition of the genus *Alcyoncellum* is utterly inapplicable to the Sponge which he adopts as a type! and, in the simple process of adopting it as such, he contrives either to misname the Sponge or to misquote the authority.

5. Dr. Gray does not succeed in throwing much light upon the question; for, still under the fatal spell, he notices *Euplectella aspergillum* under the name of *E. speciosa*, and says:— "This Sponge was first described and figured, in 1833, by MM. Quoy and Gaimard, in the 'Voyage of the Astrolabe,' p. 302, Zoophytes, t. 26. f. 3, under the name of *Alcyoncellum speciosum*, from a very imperfect specimen which had lost the netted lid, the fringes on the outside, and a considerable portion of the smaller, lower end of the tubes." * * * "There can be no doubt of the imperfect state of this Sponge, from a comparison with a worn and crushed specimen in the British Museum, that was obtained by Capt. Sir Edward Belcher, and purchased at the sale of his shells."

6 & 7. Dr. Gray has at length fully recognized *Euplectella* and the species in the French Museum as belonging to distinct genera; nay, he has founded *two* new genera upon the specimens in the Jardin des Plantes. I certainly suggested to Dr. Gray, in May last, in a letter which he has quoted (*op. cit.*), to define a new genus for the French forms; but I cannot possibly consent to the splitting of that genus. Genera are doubtless of the highest convenience if they represent *groups* of nearly allied species; but to give a generic name to almost every species, entirely does away with the value of the genera, and, instead of assisting the student, only adds to his perplexity. For a time I doubted whether these two forms were distinct species; and I was inclined to regard the specimen of *A. speciosum* as a variety grown under peculiar circumstances, and the short *A. corbicula* with the netted lid as

the normal form. I am not quite satisfied on this point even now. As I am precluded from using either of Dr. Gray's names, I substitute one which I had in MS. before I saw Dr. Gray's paper.

H. corbicula, Valenciennes (sp.). Pl. IV. fig. 1.

Alcyoncellum corbicula, Val. (in Paris Museum); Bowerbank, British Spongiadæ, vol. i. p. 176.
Heterotella corbicula, Gray, Proc. Zool. Soc. 1867, p. 531.

The Sponge is tubular, shaped somewhat like a wine-glass, about 4 inches high and 2 inches wide across the lip, and tapers downwards somewhat irregularly to a diameter of 1½ inch at the base. The wall of the cylinder is formed of a rather thick irregular network of delicate siliceous spicules, from ·01 to ·5 inch in length, loosely arranged in fascicles which cross one another at low angles, and are loosely connected and combined by a small quantity of very soft mucilaginous sarcode, which, in the dried sponge, remains as a thin yellowish film. These cords curve upwards and downwards and round, anastomosing in all directions, and leaving between them rounded openings of various sizes, and show no tendency whatever to a regular longitudinal and transverse direction. All the long spicules are formed on the hexradiate type; but the four secondary rays are usually abortive, being represented merely by four tubercles at right angles to one another, about the middle of the main shaft, which is somewhat enlarged and tuberculated at each end (Pl. IV. fig. 1 *c*). The spicules have, according to the ordinary plan of sponge-structure, a delicate centre canal, which sends off four short radii to the four secondary tubercles. The walls of the spicules consist of concentric layers of silica separated by films of sarcode, which can be readily shown discoloured by burning in a spirit-lamp. This structure can be best studied in the long spicules of *Hyalonema*, which are in every respect, except in size, essentially the same.

Scattered among the long spicules of the skeleton, there are many fully developed hexradiate spicules. Some of these are perfectly regular in form, the rays smooth and nearly equal (Pl. IV. fig. 1 *b*); but many of them are irregular, the rays are distorted and bent (fig. 1 *a*), and in some cases two or more are irregularly united together. I have little doubt that these latter indicate the first stage, as it were, to the formation of a continuous network such as we find in *Euplectella* and *Aphrocallistes*. In *Habrodictyon*, however, the coalescence never occurs to any extent, and the network remains perfectly flexible and without a trace of the raised filigree ridges which

are so characteristic of *Euplectella*. The long hexradiate clubbed spicules and the irregular hexradiate spicules make up the mass of the skeleton.

The investing film of sarcode is thickly studded with extremely minute spicules, which in the dried sponge seem to be adhering to the larger spicules and irregularly massed among them. On shaking the sponge, quantities of these minute spicules of the sarcode fall out. They are of two marked types. The most abundant are small hexradiate stellate spicules (Pl. IV. fig. 1 *b*, × 250), with the rays nearly equal, formed exactly upon the same plan as the larger spicules of the skeleton, with a well-marked but extremely minute six-rayed tube occupying the centre of the rays. The rays when broken show the same lamellar structure as the larger spicules. The second type is also very abundant; but it is rare to find these spicules at all perfect: it is the "floricomo-hexradiate stellate" of Bowerbank. The centre of the spicule is hexradiate stellate, like the other spicules; but each ray, not more than four times its own width from the point of divergence, spreads out into several, probably six or eight, expanded plates: these plates curve outwards and form a cup; they then bend upwards and slightly inwards, and become so extremely delicate that they are little more than visible under a high magnifying-power; finally they sweep upwards and outwards, ending in a trifid expansion. These trifid ends turn gracefully over, so that the processes from each of the six radii unite in producing a beautiful vase-like form. A perfect spicule with all its vases complete is an exquisite microscopic object. The star-like centres of these spicules are not very common; but the sarcode is full of the ultimate branches. (Pl. IV. fig. 1 *f*.) The vast number of these separate hooks may be explained by the extreme tenuity of their attachments to the central stars. The strain of the contraction of the sarcode in drying may probably be sufficient to break them off. These spicules appear to be most abundant near the edges of the openings in the network.

The conical sponge is abruptly truncated above, the wall ending in a well-defined ridge or lip, somewhat more dense in structure than the rest of the wall. The tube is then closed by a very irregular, horizontal, netted lid, composed of fibres which are much more thread-like and closer in their texture than those of the wall. The ultimate elements of the fibres of the lid, however, are exactly the same as those of the wall-network; only the large stellate spicules are less numerous, and the fusiform spicules are usually much shorter. The spicules of the sarcode are equally numerous and of the same character throughout.

The only known specimens of *Habrodictyon corbicula* are in the Museum of the Jardin des Plantes. They are three in number: one is perfect, another is torn through the middle, and the third is a mere fragment. Through the friendly courtesy of M. Lacaze-Duthiers, I had an opportunity of examining them carefully; and, by his permission, an admirable photograph of the perfect specimen was taken for me by M. Potteau. This photograph is copied, reduced one-third in size, in Pl. IV. fig. 1. The specimen is labelled "*Alcyoncellum corbicula*, Val. Donné par M. Saches. 1857."

H. speciosum, Quoy & Gaimard (sp.). Pl. IV. fig. 2.

Alcyoncellum speciosum, Quoy & Gaimard, 'Voyage de l'Astrolabe', Zoologie, vol. iv. p. 302.
Alcyoncellum speciosum, Milne-Edwards, in Lamarck's 'Animaux sans Vertèbres, vol. ii. p. 589.
Alcyonellum gelatinosum and *A. speciosum*, Owen, Trans. Zool. Soc. vol. ii. p. 205.
Alcyoncellum corbicula, Bowerbank, British Spongiadæ, vol. i. p. 174.
Euplectella speciosa, Gray, Ann. & Mag. Nat. Hist. ser. 3. vol. xviii. p. 467.
Corbitella speciosa, Gray, Proc. Zool. Soc. for 1867, p. 530.

The Sponge is tubular, about $7\frac{1}{2}$ inches in height, expanding gradually upwards from a contracted base $1\frac{1}{4}$ inch in diameter to a width of about $2\frac{1}{2}$ inches at the upper extremity. The network forming the wall of the tube is the same in general structure and arrangement as in *H. corbicula*, but the fibres are finer and more defined and compact in texture. The wall of the tube rises to no definite lip, and forms no terminal lid, but the ordinary network of the wall simply arches over and closes the wide end of the tube without any change of structure. As a rule, the spicules of the skeleton are identical in form and arrangement with those of *H. corbicula*; the fusiform spicules seem to be somewhat longer, and the irregular hexradiate spicules less abundant. All the sarcode-spicules of *H. corbicula* are repeated in *H. speciosum* in nearly the same numerical proportions; but in the latter species a minute spicule (Pl. IV. fig. 2 *a*, $\times 1000$) occurs in great abundance, while it is rare, if it occur at all, in *H. corbicula*. This is probably Bowerbank's "bifurcate rectangulated hexradiate spicule" (British Sponges, fig. 188); it recalls in general character and physiognomy a small spicule very abundant in the sarcode of *Hyalonema*, figured in the 'Intellectual Observer' of March last, plate 1. fig. 10. The abundance of this special spicule in *H. speciosum* has chiefly weighed with me in regarding the two forms of *Habrodictyon* as distinct species; it would be necessary, however, to examine a larger series to arrive at a definite conclusion on this point.

Dr. Bowerbank supposes that in this group the openings of the lid and those of the tube will stand to one another in the relation of oscula and pores: "The whole of the parietes are appropriated to inhalation." The distal end of the cloaca "is partially closed by a cribriform veil, the orifices of which appear to be the true oscula of the sponge." (Bowerbank, British Sponges, vol. i. pp. 176, 177.)

This is a gratuitous assumption, and seems improbable. Even in *Euplectella*, in which the formation of the lid is most perfect, the meshes of the tube-wall are individually as large as the openings in the lid, and collectively represent an area of a hundred times their extent. It seems to me that in a fixed organism of the form of *Euplectella*, with so open a structure, the resistance at the contracted "oscular area" would be sufficient to overcome any ciliary current concentrated upon it, and to send the water back through the open network. It is surely much more likely that each of the large openings in the wall is occupied by an exhalant orifice, and that inhalation takes place as usual by minute pores in the interstices between the spicules of the skeleton. Indeed this is scarcely an open question; for in the unique specimen of *H. speciosum* there is no lid, and the apertures are of the same character throughout.

The only known specimen of *H. speciosum* is that figured by MM. Quoy and Gaimard in the 'Voyage de l'Astrolabe,' and now in the Museum of the Jardin des Plantes. It is represented (Pl. IV. fig. 2) reduced one-third, from a photograph, of the natural size, by M. Potteau.

The specimen is labelled "*Alcyoncellum corbicula*, Val. Tiré par 80 brasses de profondeur dans la rade de St. Denis de Bourbon par M. Leschenault, 1819."

EXPLANATION OF PLATE IV.

Fig. 1. *Habrodictyon corbicula*, reduced one-third.
1 *a*. One of the distorted hexradiate spicules, × 100.
1 *b*. A regular hexradiate spicule, × 250.
1 *c*. One of the ordinary filiform spicules of the skeleton, showing the tubercles which represent the secondary rays, × 150.
1 *d*. The enlarged end of such a spicule.
1 *e*. A portion of one of the "floricomo-hexradiate stellate" spicules, × 800.
1 *f*. One of the separated branches, front and lateral views, × 1000.
Fig. 2. *Habrodictyon speciosum*, reduced one-third.
2 *a*. One of the spicules of the sarcode peculiar to this species, × 1000.

XXI.—*Notulæ Lichenologicæ.* No. XX.

By the Rev. W. A. Leighton, B.A., F.L.S.

Every lichenist is unfortunately well aware of the great difficulty of preserving specimens of lichens which grow on the earth. Too frequently he finds, on consulting his herbarium, that the earth on which such lichens grew has become dry and crumbled into dust, involving in such disintegration the destruction of the lichen itself, especially when this happens to possess a crustaceous thallus. To remedy this a solution of gum arabic has been sometimes used, but with partially satisfactory results only, inasmuch as the mucilage does not penetrate the earth, but only conglomerates its surface. An effective preparation appears to have been discovered by M. J. M. Norman, of Trömso, Norway. It consists of a solution of isinglass in spirits of wine, such as is used in the preparation of English adhesive plaster, which a chemist informs me is better known as "Prout's plaster." This composition, when liquefied in a vessel plunged into water of the temperature of 25°–30° C., is greedily imbibed by the earth on which the lichen grows, and becomes inspissated into a solid gelatine at a temperature below 15°. The solution may be applied by a camel's-hair pencil until the earth becomes saturated; but care should be taken that the lichen itself be not moistened with it, for otherwise it would become discoloured. When the surface has become dry, the specimen may be submitted to moderate pressure, which, after some days, produces the requisite hardness and tenacity. The favourable experience of some years encourages M. Norman to recommend this preparation to his fellow lichenists.

XXII.—*On the* Spongiæ ciliatæ *as* Infusoria flagellata; *or Observations on the Structure, Animality, and Relationship of* Leucosolenia botryoides, *Bowerbank**.

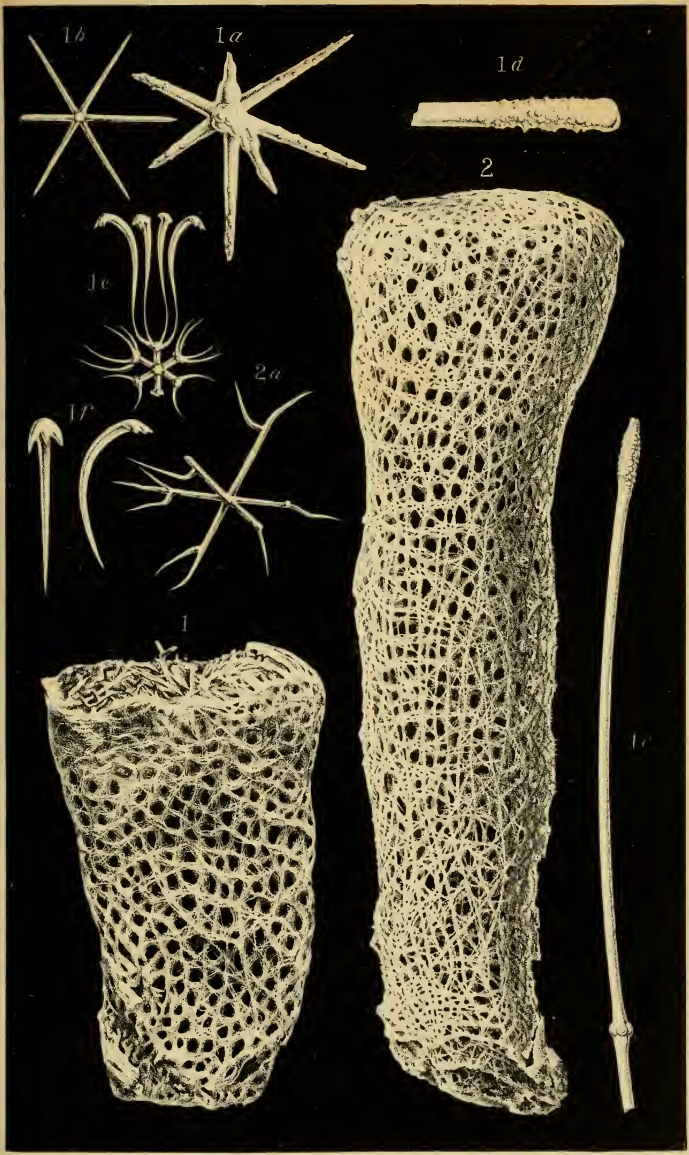
By H. James-Clark, A.B., B.S., Professor of Natural History in the Agricultural College of Pennsylvania†.

[Plates V., VI., VII.]

I have been engaged like others, for some time past, in endeavouring to clear up the doubt which prevails in the scien-

* A sketch of the contents of this memoir has already been published in the 'Proceedings of the Boston Society' for June 20, 1866; the 'American Journal of Science' for November 1866, and in the 'Annals' for January 1867.

† From a separate impression from the 'Memoirs read before the Boston Society of Natural History,' vol. i. part 3; communicated by the author.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