

XVIII. REVISION OF THE NORTH AMERICAN PORIFERÆ; WITH REMARKS
UPON FOREIGN SPECIES. PART II.

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Read April 5, 1876.¹

SINCE these Memoirs were begun, my views with regard to the affinities of the Sponges have changed completely, so that instead of regarding them as a class of Infusoria, I now look upon them as a distinct sub-kingdom or branch of animals, equivalent structurally to the Vertebrata, or any of the larger divisions which are characterized by the most important structural differences. The plan of these Memoirs does not permit me to discuss this question at present, nor is it requisite, since I have already published two papers bearing on this point, one prepared some months since for Johnston's American Encyclopedia, which will shortly appear, and one in the Proceedings of the Boston Society of Natural History for November, 1876.

In addition to the acknowledgments for assistance rendered by various institutions and individuals in the First Part of this Memoir, I have now most gratefully to add the following names. Prof. Baird, as Director of the National Museum, placed a fine collection of commercial "sorts" in my hands for identification. Dr. W. G. Farlow presented to the Boston Society of Natural History a fine collection, made on the south coast of Australia. The Academy of Natural Sciences of Philadelphia, loaned me their valuable collection of Keratose sponges. Mr. Gurdon Saltonstall made numerous inquiries with regard to the influence of physical agencies upon the West Indian Spongiæ at Nassau, and contributed thereby information having a very important bearing upon the questions discussed in the following pages. Mr. Geo. Brown Goode of Wesleyan College, Middletown, who is now collecting at Bermuda, has furnished me with information of general importance, and I am also indebted to him for a complete suite of the Spongiæ of that locality selected so as to show the varieties. Dr. E. Ehlers of Göttingen, in the most generous manner, forwarded his preparations of the skeletons of the original specimens in Esper's collection, which have been invaluable for comparison. The Messrs. Isaacs of New York gave me every facility for the examination of their large warehouse-stock of Mediterranean and American sponges, and presented several valuable specimens to the Museum of the Society. Messrs. Weeks and Potter of Boston, have also been very kind in the same way, and have presented to the Society's Collection, among others, the handsome specimen figured on Pl. 16, fig. 21.

¹ Considerable additions have been made to this paper since it was read.

Sub-order SPONGINÆ.

Family SPONGIADÆ.

The skeleton of this group differs from that of the Aplysinæ, as pointed out by Bowerbank and Schmidt, in the absence of the large tube occupying the axis of the fibres. The fibre is generally spoken of as solid, but in reality has a minute channel in the interior, which sometimes seems to be absent in dried specimens. This is probably due to the contraction of the walls of the fibre, for normally there exists in all fibres and spicules, at some stage of their growth, a hollow axis. The aspect of the keratose material is also similar to what it is in the Aplysinæ, consisting of concentric layers, and the intimate structure of these layers or concentric coats does not differ essentially. They are made up of fine fibrillæ, which may be observed at the broken ends of fibres in most species, whereas in the Aplysinæ, these concentric coats appear to be composed of more homogeneous keratode, and the fibrillæ are distinguishable only in the coarser skeletons. The fibrillæ are continuous, and not at all similar in aspect to the curious bulbous headed threads observed in some species of the Hirciniæ.

There seems to be a direct connection between the dermal membrane and the vertical or radiatory fibres, and in some cases also between this part and the secondary or connecting fibres. This is unquestionably also the case in the genus *Tuba*, and other true *Chalina* forms.

In *Spongia* proper, the dermal membrane is loaded with foreign matter in some localities, and these find their way into the fibres very rapidly. The commencement of a fibre is trumpet-shaped, the keratose matter gradually shading off into the soft membranous dermal coat of the exterior of the sponge.¹ As the whole mass increases in size, this introversion of the dermal membrane carries into the centre of the fibre a string of broken siliceous spicules and grains of sand. The secondary or connecting fibres are not usually, except in *Hircinia campana* and *Dysidea fragilis*,² loaded with any foreign material. This, and the frequent presence of aborted twigs, seems to indicate that they are formed by a process of budding from the primary fibres.

The same mode of formation is evident also in *Aplysina* and *Tuba*, but the dermal membrane appears to be harder and clearer of foreign matter. The keratose skeleton is not therefore, as is generally claimed, wholly the product of the mesoderm or sarcodous body of the mass, but partly an ectodermal product, and bearing in most cases the marks of its derivation, not only in the presence of foreign material, but in the continuously tubular structure of even the most solid looking fibres. The concentric coats of keratode are divisible into two kinds, those which are produced primarily by the growth of the extremity, which forms at one time several concentric coats, and those which are produced or deposited around these subsequently, and are evidently secreted by the mesoderm.

The range of form is quite as great as it is in the Aplysinæ. The mass of the forms in *Spongia* are solid and rounded, varying to the cup-shaped or fistular; none even of the fis-

¹ This is also shown by Barrois to be the case in the *Desmacidon fruticosa*. In the young of this species the spicules are shown in the figure and described by the author as

gathered into bundles and enveloped by keratode, which is formed by a trumpet-shaped introversion of the ectoderm projecting into the mesoderm. Ann. des Sc. Nat., June, 1876.

tular forms can be said to be tubular, since the walls are always of such excessive thickness. *Ceratella* is the extreme aberrant form which represents the arborescent *Janthellæ* among the *Aplysinæ*. These two representative forms respectively represent two distinct groups of corals, the *Janthella*, as previously described, being closely similar in the aspect and structure of the skeleton to the genus *Antipathes*, while the *Ceratellæ* approximate in aspect more closely to the *Gorgoniacæ*, though the absence of the large internal fibres confines this analogy to the external aspect of the flattened branches and the appearance of the scattered oscules, which look like the dried polyparies of the *Gorgonia*-stock.

It is usual to regard the commercial Sponges as having no specifically distinct forms, and such is the case when they are compared with the more constant forms of the higher animals, and even of most of the lower classes of the invertebrates. But the extensive collections which have passed under my hands enable me to give a formula which expresses the possible range of variation in every species. The basis of the form is the same as that pointed out by Hæckel and others for the Calcareous sponges; namely, the simple fistular or vasiform, a single tube, with most of the excurrent oscules on the inner surface. There may be every possible combination of this form, the tubes being either in the same plane, and more or less isolated in a level mass of more solid tissue, or they may be closely approximated, forming a solid head, or they may arise into separate branches, each isolated branch being a distinct tube, or association of tubes. Another series of forms have solid branches, in which the oscules owe their existence in the mass to the conjunction of a number of the excurrent canals, and are scattered all over the external surface, as in *Chalina*.

This is not the way in which the fistular forms arise, although they have been generally supposed to be identical with the separate cloacal trunks of the solid masses. Thus the tubes may be divided into two classes, those which are continuations of the original cloacal trunks of the young, as in the true *Spongiæ*, and correspond to Hæckel's idea of a fistular form; and the ordinary fistular form, of which *Hircinia campana* affords admirable illustrations. When the latter is very perfect it is perhaps impossible to decide from adult specimens alone to which class it belongs, but an examination of the varieties will generally show how it arises, especially if the earlier stages of growth of the colony are investigated.

The ordinary fistular form is a tube which owes its existence to the growth of the general surface of a previously solid mass, and receives the discharge of the excurrent oscules, sometimes these oscules being almost wholly confined to its internal surface, while in other specimens they may be scattered equally over this and the external surface also. These are the true homotypes of the primitive cloacal orifice of the embryo, and thus, although the tube of the true fistular or, when widely open, the vase-shaped form, represents functionally a single excurrent trunk and orifice. it is to be distinguished from those which arise directly out of the mass of the sponge, in somewhat the same way that we can distinguish the general cloacal cavity of *Pyrosoma* from the anal outlets of the individual ascidians. It is really a pouch or cœcum, formed by the general surface of the sponge, and is not a continuation of any single internal channel or excurrent tube, as are the true excurrent oscula.¹ Thus we can divide the series of fistular forms very decidedly from the more solid branching forms, though the latter are often found combined with the former on the same colony. From

¹ Barrois' observations show that the true canals and the endoderm in the young sponge after it becomes attached. first grand cloacal trunk arise by a hollowing out of the

the young, which is always solid,¹ we may have either the fistular tube built up, or solid branching forms, or combinations of both, the fistular arising from the solid and branching, or, *vice versa*, the solid and branching springing from the sides of the fistular. Some of the Aplysinæ have a similar extensive range, but generally the variations are more limited; whereas among the Sponginae the filling out of the entire series indicated above, is the rule, and any constancy the exception. Thus *Spongia graminea*, *Dysidea fragilis* and *Hircinia purpurea*, are exceptional, in so far as the species may be characterized to a certain extent by their forms, but these species are the least known of the group, and this can only be regarded, therefore, as a doubtful conclusion. It very often happens, also, that in a given locality a certain series of forms may be shown to be peculiar to the species; but these are likely to be indefinitely modified by the discovery of new localities, or new situations in the same locality.

The microscopical composition of the little tufts of primary fibres varies so that I can make no great use of them, as Schmidt claims to have done among the Mediterranean commercial sponges of the genus *Spongia*; but in the other genera the arrangement of the fibres in the interior is much more characteristic, and gives excellent specific characteristics. The size and fineness of the fibres and the mesh of the skeleton, are also of great value, but the most reliable characteristics are obtained from the surface of the prepared skeletons among the commercial sponges. Though still very important among the remaining genera of the sub-order, the surface is more characteristic of the genus than of the species. This is due to the fact that in *Spongelia*, *Stelospongos* and *Dysidea*, the character of the surface is more largely due to the nature and composition of primary or vertical fibres, which project more or less, whereas in *Spongia* proper the surface is very often less effected by the composition and form of the projecting tufts of primary fibres than by those which I have called secondary tufts, which are simply irregular projections of the mass of the skeleton.

This will be recognized by the study of the various forms of the American sub-species, "*tubulifera*," which has a peculiar even surface, similar to that of the European *Spongia officinalis* or cup-sponge, or by following through the various forms of *Spongia equina*, sub-species *gossypina*, with its extraordinarily tufted surface, or *Spongia agaricina*, sub-species *corlosia*, variety *dura*, with its hirsute exterior. In other genera no such wide differences exist between the external aspect of the varieties or species, the differences being principally in the greater or less fineness of the fibres and the mesh of the skeleton.

The great difficulty which is experienced in any attempt to distinguish species results from the extreme susceptibility of all keratose sponges to any change in external conditions. They appear to require for the production of the forms in abundance, tropical or sub-tropical seas, and attain by far their greatest development in the number of the forms and species in the West Indian Seas. The typical forms, the commercial sponges, are essentially confined to the waters of the Carribean Islands, Bahaman Archipelago, and the southern and western coasts of Florida in this hemisphere, and to the Mediterranean and Red Seas in the other. Australia affords a few forms, and I have heard, though I cannot substantiate the fact, of some species on the Atlantic coast of Brazil. Bermuda also has a few of the commercial kinds, which, according to Mr. Goode's report and the suite of specimens

¹ That is to say, a bulb with but one orifice or true cloacal oscule.

forwarded, are much coarser than the Key West, darker in color, and, in fact, just about intermediate between these and those of Australia. They are occasionally found in the stores, but as a rule, are used only by the fishermen themselves about their boats, the Bahama sponges being preferred for domestic purposes by the inhabitants. Of course no complete report can be written until Mr. Goode's collection, which is very large, and has been very carefully made, can be examined; but it appears that the finest forms grow only in the protected lagoons at depths varying from five to twenty feet on a sandy bottom. The temperature was not stated. They are cured in a very careless manner by exposure to the weather, a process which doubtless does not increase their value.

The true Spongiæ are all shallow water forms. In the Mediterranean, according to Eckhel,¹ they are not found below thirty fathoms, and in our own seas about the same probably, though not fished to greater depths than five fathoms. The fishery is principally carried on in the West Indies by the aid of a sort of hooked fork, two shepherd's crook-like hooks on a long pole. The fishermen cannot so successfully work at considerable depths with this instrument, as by diving, or with the diving apparatus or armor, and various forms of drags, etc., employed in the Mediterranean. The greater part of the fishery is accomplished between the depth of three and twenty feet, according to the report of Dr. Palmer, from which these remarks are principally derived. The finest qualities of American sponges are obtained in the Bahamas, the principal depot being at Nassau.

The process of preparation is not so careful as in Europe, probably owing to the greater coarseness and cheapness of the specimens. The actual fishing is done from boats, generally belonging to some schooner or larger craft. The boats are sent out from the vessel manned by two men. One sculls slowly along, while the other watches the bottom with a water glass. This is a tube about a foot square, closed by a pane of glass at the lower end, which prevents the reflection of light from the surface, and enables a keen observer to detect objects on the bottom at a considerable depth. When sponges are sighted a signal causes the sculler to stop the boat, the water glass is laid aside, and the sponges are dragged up by means of the hooks. When the fishing is at an end, or the vessel loaded, the cargo is taken to land and "killed," as it is called, by exposure for a few days to the air. After this, the now highly offensive mass is moved into the "crawls." These are pens made by driving stakes into the sand where the water is from six to ten feet deep. They are thrown into these cribs and left to be washed clean by the action of the surf. This takes about one week, at the end of which time the skeletons are examined, and if found to be entirely cleansed of animal matter, dried, sorted according to quality, and strung on cords a fathom in length. They are generally sold by the cargo. The bases are clipped off, and the sponge trimmed with shears and packed in pressed bales for transportation to New York or England, where they are largely used for the manufacture of pilot cloth, hats, etc.² They are not of sufficiently good quality to compete with Mediterranean sponges, and are therefore rarely employed for domestic purposes, except in Great Britain (?) and the countries of North and South America.

The fisheries near shore are abandoned in the winter on account of the turbid state of the water, which becomes "milky" with suspended coral sand during the more tempestuous

¹ Der Badeschwamm, by Von Eckhel. Trieste, 1873. (Eckhel Brothers.) tentively for stuffing mattresses, carriage cushions, etc., in place of hair.

² The coarser kinds and clippings are also used quite ex-

months. A more limited fishery, however, is still carried on at Anchor Keys, some thirty-five miles outside of Cedar Keys, and in other places where the water is stiller, clearer, and warmer than nearer shore.

The commercial grades coincide very closely here and in Europe, but it is quite easy to show that each of them may be considered a distinct species if one has an inclination to multiply in this direction. The grades are Glove Sponge (*Spongia officinalis*), sub-species *tubulifera*, Wool Sponge (*Spongia equina*), sub-species *gossypina*, and Yellow and Hard Head, both under the name of (*Spongia agaricina*) sub-species *corlosia*. These correspond with remarkable accuracy to the three principal grades of commercial sponges in Europe. These are the Bath Sponge, *Spongia officinalis*, the Horse Sponge, *Spongia equina*, and the Zimocca Sponge, *Spongia agaricina*. This result, in which three species appear on both sides of the Atlantic as representing alone the marketable qualities of the genus *Spongia*, becomes of double interest when these varieties, or local species as they might be called, are compared one with another. It is then found that the aspect of the surface is closely similar in each of the three; that subspecies *tubulifera* represents *Spongia officinalis*, sub-species *gossypina* offsets *Spongia equina* in the same way, and lastly, sub-species *corlosia* has the same relation to *Spongia agaricina*. The general comparison of the figures in the plates will show this well enough; but in order to make it more convincing that such a relationship is not the result of an artificial arrangement, it becomes necessary to describe some of the facts more at length.

First, their similarities of surface and aspect are precisely the same as those which experience has led me to adopt in the designation of species in this group. Thus if they had occurred in different parts of the same sea, I should not have hesitated to unite them.

Secondly, their differences can be accounted for by the difference in habitat, and are of varietal and not of specific value, according to the accepted use of the term species.

For establishing the first proposition, it is only necessary, as previously remarked, to consult the descriptions of the genus *Spongia* and the figures. The second proposition, however, requires more attention.

The whole group of *Keratosa* is confined to seas, in which the differences observable between the winter and summer isotherms are not excessive. None are found north of Cape Hatteras and the Islands of Bermuda, and doubtless a similar limit occurs to the southward of the equator; at least it is a noticeable fact that the only specimens in the Museum of Comparative Zoology are from the Island of Fernando Noronha. On the Pacific shore, Southern California and Chili are the extreme points so far known. On the opposite coast of the Atlantic they are recorded from England to the Cape of Good Hope, and also at the Island of Teneriffe. In the Indian Ocean they are found all along the east coast of Africa, at the Mauritius, and on the shores of India. They have been described from the southern part of the sea of Ochotsk, on the Asiatic continent, and specimens are not uncommon on the coasts of Australia and New Zealand. In the Pacific they have been found at the Kingmills Islands, and Hawaiian Islands. The extreme outlying form to the north on both sides of the Atlantic is the excessively coarse *Dysidea fragilis*, with its fibres loaded with debris. Those from the Cape of Good Hope and Southern Australia also belong to the coarser genera. The species cited by Miklucho Maclay from the sea of Ochotsk, seems to be one of the *Phyllospongiadae*, but there is no analysis of the characteristics of the skeleton, only the external form being described and figured in his article on the sponges

of the North Pacific, (Mémoires de l'Acad. Imp. de St. Petersburg, Vol. 75, No. 3.) It would seem, therefore, that the finer skeletons of the Keratosa, those of the genus *Spongia*, were only to be sought in the intermediate zone, where the waters are of equable and high temperature. Again, in examining the species of this genus with relation to each other, it becomes equally evident that they are finest and most numerous in archipelagos, or off coasts which are bordered by large numbers of islands, or long reefs, or in sheltered seas. I am informed by Mr. Gurdon Saltonstall that the sponges near Nassau lie on reefs very much exposed to the action of the waves, often thirty miles from land, and always in currents, sometimes running three or four knots an hour. Such currents are usual wherever groups of islands confine the tide water within certain definite channels, and they have also the effect of concentrating the floating food in the channels, or wherever tides meet. Both of these conditions are essential to successful sponge growth, namely, a continuous renewal of aerated water and a plentiful supply of food, and are probably partly the cause of their abundance in such places. This entirely agrees with my own observations upon many species on our own coast of *Chalininae* and *Halichondrida*. Constant reference to physical influences is also noticeable in the map prepared by Von Eckhel, and in the method of classification adopted by him. The marketable qualities are described as "sorts," and the different "sorts" designated by letters as "sort A," "sort B," and so on. These sorts he has found it most convenient to arrange according to localities, and thus under some "sorts" we have all the three species represented; all, however, from the same place, and all having some local peculiarity which makes them either of superior or inferior quality. The author also frequently refers to the slimy character of the bottom as a reason for inferiority, or dark color. On our side of the Atlantic this is also shown by the great difference in point of color and fineness between the Nassau and Key West sponges. The former are lighter colored, finer, more elastic and more durable than the same species at Key West, where the color is so dark that it designates at once the locality from which the specimen came. Again, the shallow water sponges are coarser than the deep water forms. This is probably due, in part, as in other species, to the quantity of sediment, which is of course less in deep than in shallow water, as, for example, at Key West in the winter time. I am informed, in this connection, by Mr. Saltonstall, who made inquiries for me among the spongers, that no fine qualities of any sponges are found within the limits of the milky water, but all the finer qualities of the marketable kinds in the deepest water in which the species occur, except, perhaps, in the case of the Reef sponge. Glove, Reef and Hard-head, are fished in shallow waters, greatest depth two fathoms, and the other, and generally finer marketable varieties, from two to five fathoms. This fact also explains, in a measure, but not wholly, the greater coarseness of our own sponges as compared with the European. For though it may be assumed from the examination of the skeletons that Mediterranean sponges are much less exposed to turbid waters, and though it may be shown by the microscope that the primary fibres contain less debris, this does not wholly explain their greater fineness and elasticity. I think that we may attribute this either wholly or partly to peculiar climatic conditions.

The Mediterranean Sea is divided by observers into two great basins, the Western and the Eastern. Dr. Carpenter's recorded soundings on *H. M. S. Porcupine* and *Shearwater*¹

¹ Proc. Royal Society. Vol. xx, p. 578, 1872.

show considerable difference in the temperature of the water during the months of August and September in the two basins. At the depth of thirty fathoms, the limit of bathymetrical distribution for the Spongiæ, the water of the Western Basin was 63° to 66° Fahr., while in the Eastern Basin it was from 66° to 68° . Dr. Carpenter's observations were made during the prevalence of very hot weather in the Eastern Basin, and in the western part of the Eastern Basin. Fortunately, however, other observers have remarked the higher general temperature of the Eastern Basin. Capt. T. Spratt¹ and Capt. Nares² also give tables from which we copy and deduce (p. 489) the following temperatures for the thirty fathom line.

It will be readily seen by the table that the conclusions of Dr. Carpenter, that the Eastern Basin was relatively to the Western of a somewhat higher temperature, is true of corresponding seasons of the year, but is subject to certain local variations, as pointed out by Capt. Spratt's observations, near Crete, where he finds 59° at 50 fath. in September, against $59^{\circ}.7$ in August in the Western Basin, and 56° near Malta, in September. It is probable, also, that in this locality the winter temperature at thirty fathoms would average very nearly what it does in the Western Basin at the same depth, since even in June, with the air at 80° , it holds a temperature as low as 68° , within 5° of the extreme western station of Carpenter. In the Grecian Archipelago, also, the deep water temperature of 56° comes up to the one hundred fathom line, and shows again an approximation to the lower temperature of 55° near Malta, and at Station 1 of Carpenter at the same depth. This is important to the present subject, since in the Grecian Archipelago one of the finest qualities of *Spongia officinalis* is found, but *Spongia equina* is rare, and of an inferior quality, according to Von Eckhel. Though in the soundings this cold water does not reach the fifty fathom line, it becomes quite probable that in the winter months it very often rises as high as this.

Admiral Smyth's³ work on the Mediterranean, which also confirms these remarks, is very instructive on other points, which it is necessary to consider before proceeding farther. This author states that the average difference between the temperature of the surface water to the depth of eight fathoms, and the temperature of the air, both taken at the same hour, is about $3^{\circ}.5$ colder for the summer, and $1^{\circ}.5$ Fahr., warmer for the winter. This appears to be very small, but it will be observed in the table that in summer the difference must frequently be very slight between the surface and the air where the thermometer stands near 70° , or in winter, when it is about 60° .

The difference of temperature between the Eastern and Western Basins of the Mediterranean may possibly help us to account for the peculiar distribution of the commercial sponges, and their partial absence from the Western Basin. They are found on the Dalmatian shore of the Adriatic, as far as Triest, and on the shores of Tunis, Barbary and Morocco, as far as Ceuta, but not elsewhere in the Western Basin. If we take into consideration the observations of Admiral Smyth with regard to the relative temperature of the air and surface water, and remember that the latter, to the depth of 30 fathoms in a comparatively still sea, like the Mediterranean, must be constantly influenced by the seasons whenever there are no constant currents, and no proximity to a large body of colder and deeper water, these difficulties will, in a measure, disappear. The winters along the shores of Spain, France and Italy, are quite severe as compared with the corresponding periods

¹ Peterm., Geogr. Mittheil., 1862, p. 431, and Nautical Magazine.

² Proc. Royal Soc. Vol. xx, p. 97.

³ The Mediterranean. London, 8vo. 1854.

	E. of Rhodes, Aug. 25.	Greek Archipelago, July 25.	Near Crete, Sept. 20.	Near Crete, June 14.	West of Alexandria, April 6.	N. E. of Syrtis, Station I, Oct. 11.	Syrtis, Feb. 21.	Syrtis, Feb. 27.	Egypt, Nov. 15.	Egypt, April.	S. E. Malta, Station III, Oct. 3.	E. of Malta, Station II, Sept.	Between Malta and Tripoli, May.	Near Straits of Gibraltar, August.
Air.	88° 0	86° 0	76° 0	80° 0	68° 0			56° 0						
Surface.	82° 0	78° 0	75° 0	73° 0	62° 0	79° 0	61° 0	60° 0	73° 0	63° 0	80° 0	77° 0	62° 0	74° 5
30 fath.	78° 5	71° 5	68° 0	68° 0	61° 5	75° 5	62° 0	60° 5?	71° 0	61° 5?	66° 2	60° 0	62° 0	63° 0
50 fath.	77° 0	69° 0	59° 0	63° 0	60° 0?	67° 0	62° 0	61° 0	68° 0	61° 0	61° 0	56° 7	62° 0	59° 7
100 fath.	73° 0	56° 0+	56° 0+	59° 7	59° 5?	59° 5	62° 0	61° 5	62° 5	59° 5	58° 5	55° 5	62° 0	55° 1
200 fath.				59° 7	59° 5?	58° 5	62° 0?			59° 0	56° 5		62° 0	
270 fath.							62° 0			59° 5				
295 fath.												62° 0		
300 fath.					59° 5	57° 0								
500 fath.						57° 0								
586 fath.													55° 0	
1240 fath.		3		59° 5										
1456 fath.												55° 0		
1650 fath.											56° 0			
1970 fath.						56° 7								

on the shore of Morocco and Barbary. According to Berghaus, at Palermo, in Sicily, the average winter temperature is about $52^{\circ}.3$ Fahrenheit, $11^{\circ}.3$ Centigrade; at Naples, the next warmest locality noted in the Western Mediterranean, it is $49^{\circ}.2$ Fahr., $9^{\circ}.8$ Cent. All the more northerly parts on the coasts of Italy, France, or Spain, have a lower average winter temperature, including Cagliari, on the southern shore of Sardinia.

According to Admiral Smyth, the lowest aerial temperatures recorded were 36° in Sicily and 34° in Sardinia, and he gives for the "middle latitudes" of the Mediterranean a variation of from $50^{\circ}.1$ to $44^{\circ}.3$ for January, an isotherm of $46^{\circ}.2$. This of course refers to the Western Basin, where these observations were made, and accords quite closely with the aerial isochryme of 50° , as laid down by Schouw, which runs a little south of the central parallel of 40° in the Western Basin. With an aerial isotherm of 46° or an isochryme of 50° , it may be assumed with great probability that the water at the depth of 30 fath. would not be above 55° , since even in summer, at this depth, near Malta and in the extreme western station of Carpenter, the temperature does not range above 63° , and remains at 55° at 100 fathoms in two localities. It will be seen farther on that this temperature, though lower than that of the coasts of Barbary and Morocco, is not sufficient of itself to account for the absence of commercial qualities of the Spongiæ from Sicily, Sardinia, and the southern coast of Spain.

The more northerly parts on the southern shore of the same basin have a considerably higher average; thus Algiers, according to Berghaus, has an average winter temperature of $54^{\circ}.3$ to $61^{\circ}.7$, or about 58° , which is probably the correct mean, and in Schouw's map by Berghaus, it stands nearly upon the isochryme of 54° .

Tunis and Cairo, to the westward, have still warmer climates. Admiral Smyth gives the following temperatures; at Algiers, $86^{\circ}.8 - 41^{\circ}.5$; at Tripoli, $92^{\circ}.5 - 51^{\circ}.2$. No mention is made in any authority to which I have been able to gain access of such cold weather as undoubtedly is not infrequent even in southern Italy, Sicily and Sardinia, and the whole shore from Tripoli to Syria lies close to the isochryme of 57° .

The condition and inferior quality of the sponges on the Algerine coast show that here we have reached the extreme limits of their habitat, and the average winter temperature of the surface water, according to Admiral Smyth's allowance for variation, would be $58^{\circ} + 1^{\circ}.5 = 59^{\circ}.5$, a result which accords very closely with Schouw's map, and the observed deep water temperatures in the Western Basin and near Malta, at 100 fathoms. These calculations would seem to be very favorable to the view that both the bathymetrical and the geographical distribution of the Spongiæ were limited by the minimum temperature of 55° , but there are other localities to be considered.¹

The area of the earth's surface drained by the rivers which flow into the Black Sea, amounts, according to Carpenter, to 939,000 square miles, while its own area, and that of the Azoff Sea, is only 172,500 square miles, and its connection with the salt waters of the Mediterranean is limited to the narrows of the Bosphorus. Under these circumstances it is not remarkable that its salinity or density, as compared by means of its specific gravity with that of ordinary sea water, should vary from 1.012 to 1.014, and be less than half that

¹ Admiral Smyth is probably in error with his deep sea temperatures. The discrepancy between his statements and those of Spratt and Carpenter cannot be otherwise accounted for; the average being, according to Smyth, 42° to 43° below 180 fath., while 55° is the lowest given by the other authorities.

of the Mediterranean, which in the Western Basin varies from 1.0280 to 1.0284 in the neighborhood of Sicily, and is even denser in the Eastern Basin, rising between Malta and Crete from 1.0284 to 1.0288. If this want of an average amount of salinity did not account for the absence of the genus *Spongia*, and possibly all the *Keratosa* from the Black Sea, the temperature of the water would, the winters being exceedingly severe. The isotherms of the summer months, according to Carpenter,¹ range between 70°–80°, while in the winter the variation is 30°–40°. This extreme cold is due to the sharp northeast winds which come over the snow-clad plains of Russia from the Arctic regions. Ice is therefore very abundant along the northern shores in winter, and the temperature of the water probably falls quite low, since in the temperature taken by Commander Wharton,² of which unfortunately only one observation is recorded as made in October, the water was only 62° to a depth of 30 fathoms, then a cold current of 54°, and below this again the thermometer rose to 60°.

If either the temperature or density of the water had been exceptional, we might have gained some additional information, but as it is, we cannot assume that either cause would have been sufficient to account for the absence of the *Spongiæ* from the Euxine. According to Carpenter, in his articles on the Mediterranean and Black Sea, there is a strong current continually flowing at the depth of twenty fathoms from the Mediterranean into the Black Sea, and a return surface current from the Black Sea into the Mediterranean. The sponges occur necessarily in the shallower waters of the Sea of Marmora, since they are said by Von Eckhel to be fished for mostly with the harpoon, and are probably exposed more or less to the influence of the surface current. Under these circumstances they must very often be able to endure a degree of cold during the winter, and an amount of change in the density of the water, for which it becomes difficult to account, even taking into consideration the inferior quality of their skeletons. It is possible, however, that the water of the northern part of the Black Sea may not affect the temperature of the southern part to such an extent as would at first sight appear probable, and that, notwithstanding the lower temperature of the northern shores, the general temperature of the surface water during the winter immediately east and west of the Bosphorus may not fall below 55° as a minimum. The average of the aerial winter temperature of Constantinople, according to Berghaus' map, is about 40°.6, but this does not agree closely with the lowest temperature recorded by Admiral Smyth of 53°.4. It does not seem probable that this comparatively high average winter temperature could be maintained if the waters of the Black Sea and Sea of Marmora were to become very cold in winter, but it is a much lower temperature than is found on the Algerine coast. The aerial isochryme, however, is as low as 42°.5, according to Schouw's map.

The northern shore of the Ægean Sea and the eastern shore of the Adriatic Sea are populous with sponges, and yet the former throughout its whole extent, and the latter from Ragusa to Istria, have nearly the same average winter temperature, and possess a colder climate in winter than the coasts of southern Italy or Spain, where no *Spongiæ* exist. Again, upon consulting the invaluable little Eckhelian pamphlet, we find that the sponges correspond in quality to this climatic change. The sort found at the head of the Ægean is said to be the *Spongia officinalis* alone, and to have a "heavy, hard, close, very hairy skeleton, often containing slime," and it is farther added that it is not much liked, and is

¹ Encyclopedia Britannica, ninth edition.

² Proc. Roy. Soc. Vol. XXI, No. 145, p. 387.

usually fished with the harpoon. The same species exists also alone at corresponding localities along the shore of the Adriatic, and at the extreme locality, the Island of Istria upon the limit of its distribution, it is said to be very rare, the form to be ugly, the skeleton hard, the color dark. Farther south, along the Dalmatian coast, it becomes abundant, finer in texture and of a lighter color, but it is still inferior to the more southern or Levantine variety. In considering such classes of facts, it must also be borne in mind that the habitat of a certain sort or variety may largely determine the quality of the skeleton, even where the temperature may be very favorable. Thus to the south of Quarnero, among the islands, a much better quality of *Spongia officinalis* occurs than in the milder sea about the Ionian Islands, which, as Eckhel remarks, is probably attributable to the slimy character of the bottom.

A sufficient reason for the absence of the Spongiæ on the Italian shore can be found in its physical characteristics. The Adriatic is a comparatively shallow sea, and according to Admiral Smyth's soundings, the greatest depth between Istria and Venice is 20 fathoms, and in the centre of the sea to the southward, only 500 fathoms. A constant current from the south passes northward along the eastern, and southward on the western shore. It is clear and probably warm in its passage north during the winter from the south, and it seems probable that this current parts with much of its heat in the shallower waters of the Gulf of Venice, falling, perhaps, to a temperature which would prohibit the extension of the Spongiæ beyond Trieste. For if we apply Admiral Smyth's rule to the correction of the average winter temperature for all these more northern localities, the Sea of Marmora, the northern shore of the Ægean and Gulf of Venice, we find that the average temperature of the water for these places would be represented by $56^{\circ}.5 + 1^{\circ}.5 = 58^{\circ}$. But the isochryme of $42^{\circ}.5$ passes directly through the Sea of Marmora, the northern part of the Ægean and Ragusa, leaving Istria considerably to the north with an isochryme of about 39° .

It does not seem at all probable that any species of the true Spongiæ can live in surface water which is affected for any length of time by such a degree of cold, and the only explanation to be offered of their existence at such northerly points as Istria, must lie in the warmth of the current from the south. If this is taken into consideration, and it is also observed in the table how great the variation is between the air and water during the winter season on the coast of Syrtis, the water being fully 16° warmer than the air; and how great the variation is also in summer, when the difference is sometimes 10° , as noted by Dr. Carpenter, the air being 90° and the sea 80° ; it becomes evident that the water of the Mediterranean, like that of other seas, responds very slowly to extreme changes of temperature. The Adriatic current alluded to not only probably retains a large part of its original temperature in its progress along the coast of Albania and Dalmatia, but even at Istria we should expect to find at least 15° difference between the extreme isochrymal of the air and that of the water. If this is correct we should reach the temperature of $39^{\circ} + 15^{\circ} = 54^{\circ}$ as an isochrymal at Istria, and $42^{\circ}.8 + 15^{\circ} = 57^{\circ}.8$ as the probable isochrymal of the water at Ragusa. A similar result can be obtained also from the extreme aerial isochrymal of the Sea of Marmora, if it is worth while to make a calculation in such a peculiar locality, namely, $42^{\circ}.5 + 10^{\circ} = 52^{\circ}.5$, as an isochrymal for the water. These being the most northerly or most unfavorable points at which the Spongiæ are known to exist, we cannot be far wrong in assuming from the facts and inferences above cited, that in a comparatively quiet, clear sea like the Mediter-

ranean, they are never for any length of time exposed to a lower degree of cold than 50° to 55° , and that this produces a very unfavorable effect upon the quality of the skeleton.

This of course directly negatives the conclusions drawn from the conditions found to exist on the southern coast of the Western Basin, as contrasted with those of Sardinia, Sicily, and southern Italy, and it becomes evident that the temperature alone cannot be the cause of the absence of the Spongiæ from these shores.

Locally we can say with some degree of probability, that the temperature and the fresh waters of the Po, with the vast quantity of silt which is carried by it to the sea, and distributed along the shore to the southward, have proved to be barriers in this direction. When, however, the attempt is made to explain why they are absent from all the other northern shores of both the islands and the coasts of the Western Basin, all single causes seem to fail, and I can only suggest the following, viz., that, where the limits of temperature are neared, the absence of small islands, or very slight local peculiarities, may occasion the absence of *the commercial sorts*. It must also be remembered that it is not distinctly known that all are wanting; our information is limited wholly to the commercial sorts, and the other coarser and non-marketable varieties have not yet been systematically hunted for by naturalists.

The finest sponges in the Mediterranean, those of the Levant and off the Syrian and Tripoli coasts, are found between the average aerial winter temperatures of 63° and 70° , and the isochrymals of 50° – 57° , and the table (p. 489) shows that at no time of the year are these, which, as stated by Von Eckhel, occur in the deeper water at a distance from the coast, probably exposed to a lower temperature than 60° .

This repeated approximation of all calculations of the surface temperature, however made or wherever made in the winter, to a marine isochrymal of 55° to 60° , although not so convincing as a series of actual observations, appear to point this out as probably a close approximation to the actual isochrymal which limits the geographical distribution of the prime qualities of commercial sponges, and this view derives great additional support from the fact, already stated, that this is the constant temperature of deep water in summer, and the probable isochrymal at the depth of 30–50 fath. in winter in a large part of the Mediterranean.

I am indebted to the U. S. Signal Service Office for a series of tables giving the average temperature for all the months in the year of the surface water of St. Marks, on the west coast of Florida, lat. $28^{\circ} 55'$, long. $84^{\circ} 07'$; Punta Rossa, also on west coast, in lat. $26^{\circ} 29'$; long. $82^{\circ} 10'$; Key West at the extreme south, and Jacksonville on the Atlantic side. The following is a copy of the average temperatures of all the months in the year. The St. Marks' column, however, is taken from only one complete series of observations; while the Punta Rossa, Key West and Jacksonville averages are all deduced from three years of continuous observations.

The isotherm for the month of January at St. Marks is $63^{\circ}.5$, for Punta Rossa, $68^{\circ}.8$, and for Key West 73° . Anchor Key and Cedar Keys, famous localities for spongers, are between St. Marks and Punta Rossa. These temperatures differ but a few degrees from the aerial isotherm, which is at St. Marks 5° , at Punta Rossa 10° , and at Key West $4^{\circ}.5$ colder than the water, whereas in summer the temperature of the air at these localities is respectively $1^{\circ}.5$, 6° and 5° warmer than the water. The marine isotherm for the month

APPROXIMATE AVERAGE TEMPERATURES.¹
MEAN OF MAXIMUM AND MINIMUM.

	St. Mark.	Punta Rossa.	Key West.	Jackson- ville.
January	63°.5	68°.8	73°.0	58°.0
February	63°.5	71°.0	73°.8	60°.7
March	63°.5	74°.3	75°.8	68°.0
April	69°.0	75°.5	76°.5	72°.3
May	74°.0	81°.9	81°.2	79°.2
June	76°.5	82°.7	84°.8	85°.3
July	78°.5	86°.0	85°.0	86°.8
August	78°.5	86°.0	82°.8	85°.8
September	75°.5	87°.5	84°.2	82°.5
October	67°.5	79°.5	80°.2	74°.8
November	64°.2	75°.2	76°.8	67°.5
December	62°.0	67°.7	72°.5	59°.5
Yearly ave'ge	69°.7	78°.0	78°.9	73°.4

northward to New York, which would effectually prevent their existing even in the most sheltered bays and nooks. Besides this the aerial isotherm of January does not represent the unfavorable conditions of the climate, since at long intervals very severe winters occur as far south as Chesapeake Bay, when the surface water must become very much chilled by the large amount of ice formed in the numerous smaller bays, rivers and harbors, north of Cape Hatteras. The severest test of the ability of the Spongiæ to withstand the climate would therefore be shown by the average of the minimum or isochryme of the water for January, for several successive years, taken near shore, which must necessarily be very much below that of the average temperature or marine isotherm for that month at even a short distance from the Atlantic coast, on account of the inshore or return cold current from the north, which prevents the influence of the warm waters of the Gulf Stream from reaching the surface waters of the coast. That the coarser varieties of the commercial sponges can survive even these adverse conditions to a certain extent, is shown by the specimens of *Sp. agaricina*, sub-species *corlosia*, var. *divisa* from Stono Inlet, South Carolina.

¹ These were taken on the bottom, at depths varying from seven to twenty feet, according to the station.

of January of 68°, was traced by Dana² only as far as Cape Carnaveral, but, as this table shows, it probably begins again on the west side, at or near Punta Rossa, and bending northwards probably includes nearly the whole area of the Gulf of Mexico. The whole of the region favorable for the production of the commercial qualities, lies between St. Marks, on the coast of Florida, with an isotherm for January of 63.5, and the equatorial isotherm for January of 80°; south of this equatorial isotherm, however, the limits have not been ascertained, the data, both as regards the sponges themselves and the temperature, being deficient. Although the non-marketable varieties occur at several places in the northern zone, such as Vera Cruz, Cuba, and so on, the finer sorts are only found along the west coast of Florida, among the Keys, and in the insular waters of the Bahama and Carribean Islands. Their absence from a large part of the shores of the Gulf may be attributed to the sandy or soft character of the coast, to the effect of the silt of the Mississippi and to the absence of outlying islands. The absence of the commercial kinds from the Atlantic shore may be explained in a similar manner by the frequently open and sandy or clayey character of the entire coast

² Corals and Coral Islands. New York, 1872.

The finding of these specimens and the considerations above noted, induced me to apply again for assistance to Gen. Myers, Chief Signal Officer, for the temperatures during the months of January and February, at the stations along the Atlantic coast south of Cape Hatteras. The records, which were immediately forwarded, and are in the accompanying

TEMPERATURE OF WATER FROM OBSERVATIONS TAKEN AT BOTTOM.

	WILMINGTON, N. C.		CHARLESTON, S. C.		SAVANNAH, GA.		JACKSONVILLE, FLA.	
	MAXIMUM.	MINIMUM.	MAXIMUM.	MINIMUM.	MAXIMUM.	MINIMUM.	MAXIMUM.	MINIMUM.
January, 1874,	53°	42°	—	—	54°	44°	59°	50°
February “	54°	42°	—	—	—	—	65°	57°
January, 1875,	49°	40°	53°	45°	53°	43°	62°	56°
February “	50°	41°	56°	42°	57°	42°	64°	55°
January, 1876,	54°	47°	68°	48°	58°	46°	68°	56°
February “	55°	49°	57°	41°	56°	49°	66°	58°
January, 1877,	51°	41°	54°	43°	58°	37°		
Average maxima and minima for January	51°.7	51°.7	58°.3	45°.3	55°.7	42°.5	63°.0	54°.0
Isotherm for Jan.	46°.3		51°.8		49°.1		58°.5	

table, give the strongest support to the idea that the temperature has probably more influence than any other cause in limiting the distribution of the Keratose sponges to the more southern localities. The commercial qualities being in all cases shallow-water animals could not, without great difficulty, spread to the northward from the Key West region to the region along the Atlantic coast of Florida; they would be exposed after passing Jacksonville, not only to all the unfavorable conditions of the open sandy shores, but also after a few fortunate forms had gained the inlets, the general absence of favorable holding, and perhaps feeding grounds, would be supplemented by an average temperature approximating during the month of January to the unfavorable limits previously traced in other localities. North of Jacksonville the temperature falls below 58° very rapidly, becoming very unfavorable to the existence of these forms; thus at Savannah it averages as low as 49°. Here there is evidently some local disturbance, since the regular rate of decrease northward would make this some degrees higher. At Charleston, the January temperature is only 51°, and at Wilmington, 46°. These averages, and the recorded isochrymals, are somewhat remarkable confirmations of the deductions previously made in the Mediterranean and

along the coasts of Europe and America, with regard to the temperature limiting the northern spread of the genus *Spongia*.

It was entirely upon this ground that I first began to doubt the accuracy of the marine isothermals for January of 62° , 56° , 50° , which are laid down on Prof. Dana's map as coming to a focus at Cape Hatteras. These should be carried down the coast, deviating inside or west of the Gulf Stream to the southward, as does the more accurately drawn isotherm of 68° , and should be drawn nearly parallel to the coast to some point south of Jacksonville for 62° ; to some point south of Savannah, probably Altamaha Sound, for 56° ; and to Cape Roman, north of Charleston, for 50° . This same rate of decrease would bring the line of 44° , which ends at Cape Cod on Prof. Dana's map, down the coast to a point a little south of Cape Lookout, on the shore of North Carolina, and reduce the average temperature of the water at Cape Hatteras, during the month of January, to about 40° .

This appears to be the result of the cold inshore current, which during the winter probably comes closer inshore, and combines with the atmosphere in affecting the surface water. Such a current has been traced by the United States Fish Commission to the south of Cape Cod, even in the shallow waters of the Vineyard and Long Island Sounds, and is constantly referred to in the reports of the United States Coast Survey as coming to the surface farther out to sea. This return current is crowded into a smaller space as it runs southward, and would therefore be likely to exercise a much more important influence proportionally to the winter south of Cape Hatteras than to the north of that Cape, upon the surface waters in January. Whether this is so or not, it is very remarkable that the selected limit for the spread of all Keratose forms northward on the American Coast was Cape Hatteras, and it now turns out that the temperature of the surface water must be nearly the same as it is along the northern limit of distribution of the same forms on the European side, namely, a January isothermal of 40° on this side as compared with 41° on the other.¹ It ought to be observed here also, that Charleston is the most northerly point at which a Keratose form has actually been found. This species, according to Prof. McCrady's verbal description, must have had a very coarse skeleton allied, if not identical, with *Dysidea fragilis*, which, as previously observed, is the most northerly species on the European side also. It is possible, therefore, that the generally unfavorable and sandy character of the coast may have limited the distribution to a point as far south as Charleston; but it would be unsafe at present to adopt this view, Cape Hatteras being the natural limit of the entire littoral fauna.

Dr. Buist² states that the temperature of the water in the Red Sea, between Aden and Suez, varies between 65° and 85° . The same authority subsequently published³ a long account of this region, accompanied by tables of temperatures from which the following remarks were taken. The density of the water, except in the Gulf, was not excessive, averaging about that of ordinary sea water except in the Gulf of Aden. The transparency and purity of the water was very great, and this might also be remarked of the waters of Florida and the Bahamas in the summer. Ten feet below the surface the temperature at Suez does not fall below 70° , or the air lower than 72° in January or February, and the heat in summer is excessive, 80° , 82° , 92° , being not infrequently recorded at Aden, and 80° ,

¹ See Dr. Carpenter's map. Proc. Royal Soc. Vol. xx. ² Trans. Bombay Geogr. Soc. Vol. xiv, p. 3, 1859.

³ Trans. Bombay Geogr. Soc. Vol. ix, p. 39, 1850.

83°, 86° at Suez. These great heats are also occasionally reached on the coast of Florida; at Punta Rossa and also at Key West, it is sometimes 90° or 92°.

Capt. Pullen's¹ soundings give remarkably low temperatures for the depths of the Red Sea, 44° at 1889 fath., surface 81°.5; 43°.5 at 1500 fath., surface 82°; 45° at 1200 fath. with surface 81°.5. The northern part of the Red Sea, where, according to Von Eckhel, most of the commercial sponges are found, has an aqueous isochrymal of about 70°, and this accords with Carpenter's remark in the work above quoted, that the waters of the Red Sea are uniformly 71°, but not wholly, since he has inferred that this is the mean temperature at all depths, which cannot possibly be the case unless all other observers are in error.

The sponges of the Red Sea, according to Von Eckhel, are inferior to, and rarer than, those of the Mediterranean; he compares them to the Zimocca variety, describing the skeleton as brittle, entirely red, and very dark at the base. Not having seen any specimens unquestionably from this locality, I cannot compare them with the Key West and Australian varieties; but they are evidently, so far as quality is concerned, more like the coarser Zimocca sponges of the Mediterranean, since Eckhel describes them as mixed with these in the trade. The extremely hot temperature of the Red Sea does not, therefore, when acting in perfectly clear water, produce so great changes as when the waters are more loaded with sediment, as in the shallows of the Florida coast, or else these specimens could not be sold commercially even in the company of the inferior Mediterranean qualities.

I have seen but few true Spongiæ from Australia. These are coarser than their congeneric form, *Spongia discus*, and, like this species, have an excessively dark, rough skeleton. The neighborhood of Sydney, where they were collected, lies under the marine isochrymal of 62°, as laid down by Dana, and the coast is open and apparently unfavorable for the growth of the commercial sorts. This, and the aspect of the specimens, leads me to think that they were beach specimens which had drifted from the coast of Queensland, which, judging from the descriptions of voyagers, must be exceeding favorable, inside of the great boundary reef, for the growth of the true Spongiæ. The collection of the *Keratosia* received from Dr. Farlow, was made at Port Phillip, near Melbourne, on the south coast of Australia, and though the genera are well represented, there are among them only three specimens allied to true Spongiæ; these have coarse, loosely constructed skeletons, and I have been obliged to propose a new generic name, *Carterospongia*.

Although the distribution of the Spongiæ is not limited by the same isochrymal as that demonstrated for the reef building corals by Prof. Dana, namely, 68°, the association of these with the Spongiæ having coarse and inferior skeletons cannot be a matter of accident. The coral reefs afford good holding ground for the bases of the colonies and protection from the excessive surf of ocean shores, while they grow in water, the remarkable clearness of which to a considerable depth is the constant subject of remark. These are undoubtedly favorable conditions, since they are common also to the Mediterranean waters. The great quantity of calcareous sediment, however, which is churned by the waves in the winter on the borders of a coral reef, is not present in the Mediterranean; and the average temperature, also, which is very much higher than that under which the finest sponge skeletons are produced in the Mediterranean, cannot be considered as

¹ Trans. Bombay Geogr. Soc. Vol. XIV, p. 44, 1859.

favorable. These last, then, are probably the direct causes of the inferiority of the skeletons of the commercial varieties found in this association.¹

These views, as a whole, therefore depend for confirmation upon the accuracy of the calculations with regard to temperature, and upon the following facts: that the inferiority of the skeleton, which is common at Key West, with the same isochrymal as the Red Sea, is not found to the same degree in the sponges growing in the clearer waters of the latter; that the coarsest quality of all the Mediterranean sponges, the "Gerbis sort," and other coarse "sorts," grow in localities along the coast, where they are most subject to the action of suspended matter in the water; but all of these are, however, on account of the clearness and medium temperature of the Mediterranean waters, as compared with those of other seas, of much finer quality; that the coarser kinds of the same quality or variety grow nearest the shore, and the finer kinds in deeper water, and also according to Nassau spongers, are more apt to occur upon marly ground, where the sediment is finer than upon other kinds of bottom; and lastly, that the inverse ratio between the quantity and even the prevalence of different kinds of sediment, such as sand grains or spicules, and the resiliency and flexibility of the fibres may be demonstrated with the microscope in any series of specimens.

It may be well to notice, however, that the openness, or apertion, which usually accompanies and appears to correlative with coarseness of the fibre, cannot be accounted for in this complicated way, but, strictly speaking, must be considered as one of the elements of inferiority which invariably accompanies a skeleton having a loose microscopical texture or mesh, and harsh, inelastic, or easily torn fibres, but is also, though rarely, found in skeletons of very fine quality, especially at an early age. Thus it may be said, that it is undoubtedly a common characteristic of all the inferior qualities of Mediterranean, and of all the Carribean commercial sponges, without exception, which, though they may have very fine or very coarse or inelastic fibres, are always permeated in the interior, and have the surface also cut up, by larger and more numerous canals than the corresponding Mediterranean species. The Australian species of the genus *Spongia*, though coarser in fibre than the Carribean forms, are equally open, and are harder when dry than any of the former, except certain rare varieties of *Spongia agaricina* and *Spongia discus*. In this connection it may be appropriate to call attention to the forms, all belonging to the unmarketable varieties of the genus *Spongia* which have been found in hot climates, as for example, at the Mauritius and the Hawaiian Islands with an isotherm for the coldest months of 74°, Kingsmill Islands and Feegee Islands with one of 80°, at various places in the Bay of Panama and Gulf of Mexico with isotherms for January of from 74° to 80°. The extremes of temperature are represented at Stono Inlet, South Carolina, with a marine isochryme of about 51°, and Sydney, Australia, with one of 56°. The evidence afforded by these, all of which have very open, coarse, and brittle skeletons, therefore confirms the opinion, that this characteristic of apertion may be with great probability attributed perhaps exclusively to the influence of an unfavorable temperature, which, if the limits suggested in this paper are correct, might be either the amount of cold indicated by an

¹ What effect the superior density of Mediterranean water may have, it would not be possible at present to say, the data being insufficient, but it is probably very slight. The chemical composition of the water has also not been sufficiently in-

vestigated, and this may prove to be of greater importance, since the variation is probably much greater in this respect, especially in the vicinity of coral reefs.

isotherm for the coldest months of about 50° , and possibly lower to some as yet undecided limit, or the equally injurious heat shown by an average for the same month of about 65° and upwards, to 80° .¹

There is a darkening of the color of the fibres about the base, and frequently of the whole sponge, which may occur with any of the inferior qualities in any cold climate, or unfavorable situation, as at Istria, and varies also with the age and size of the specimen. These influences, however, never produce so marked an effect as in a hotter climate, nor does the deterioration of the fibre and of the density of the skeleton go so far; nevertheless, the Nassau sponges, which are lighter colored than the Gerbis sponges, and the remarks above on the influence of suspended matter near the shore, seem to point out very conclusively, that heat does not control the color entirely, though it may largely influence it.

Another point in this connection is, that the deepest color is always in the interior, and the lightest colored parts are external, in the position most exposed to the action of light; and this, though not necessarily, is probably the hottest part of the organism during the heated term of the year in the shallower waters, where the darkest colored forms are mostly found. It has been suggested by Eckhel that this coloration was due to the presence of iron in the sediment or sea bottom, but this could hardly be the case in the vicinity of coral reefs. In fact, dark internal coloration appears to result from, or correlate with, the deterioration of the skeleton as an internal change in structure, which varies with the species, the age and the health of the specimen, and probably with the chemical composition of the fibres themselves.

If we now, in conclusion, turn our attention to the general limits of the distribution of the Keratosa as a whole, we find that the extreme points already mentioned may be all inclosed within a central zone extending on both sides of the equator to the isothermals for the coldest months in the year of 40° Fahr., and these, therefore, would approximately represent the natural boundaries of the circumterrestrial area occupied by the order.

This distribution does not seem explicable in any way unless we assume, that the Keratosa originated in North America, and have spread in all directions from this area. This hypothesis also appears to me to explain more satisfactorily, according to our present

¹A collection just received from the Museum of Yale College contains a specimen of *Spongia discus*, var. *auklandensis*, from the Auckland Islands, south of New Zealand, latitude about $50^{\circ} 20'$, and longitude 167° , and therefore if this locality is correct, affording an instance of a true Spongian form living in water, according to Dana's map, with a July isotherm of about 41° . I was led to doubt the accuracy of this isothermal line by this fact; but the examination of Mr. J. Prestwich's Memoir on "Submarine Temperatures," in Trans. Royal Soc., Vol. 165, Pt. 2, 1876, which has just come to hand, confirms Dana's view. The temperatures for the surface recorded in the neighborhood of New Zealand, on the parallel of Dana's isotherm for July of 50° , are as follows: In January, near the west coast of South Island, at 534 feet, $55^{\circ}.8$, and surface 63° ; in Cook's Straits, surface $63^{\circ}.5$ to $64^{\circ}.4$, off the southeast coast of North Island, in February $65^{\circ}.2$ for surface, and $58^{\circ}.7$ at depth of 506 feet. Near Antipodes Island, on parallel of $49^{\circ}.17$ considerably to the east and a little north of Auckland Islands, the temperature of surface was found in December to be 53° in six observations by Sir James Ross, and to the

southwest of Auckland Islands, near the Macquarrie Islands, in lat. 55° , long. 157° , the surface temperature in January varied between 31° - 44° , an average of $37^{\circ}.5$, and in latitude $57^{\circ} 52'$, with nearly the same longitude as the Auckland Islands, the thermometer registered 42° in December. Unfortunately these temperatures were taken during the hottest months, and thus while 41° may be a very good average for the surface in this region during the month of July, and may serve the purposes of a general map, like that of Prof. Dana, it does not accurately express the isotherm for the coldest months in the year in the shallow waters of the Auckland Islands, which appear to lie to the east and north of the colder area just south of Van Diemen's Land, and it is possible that they may average some degrees higher.

The only indubitable exception, which I have found, to this (50°) limit of temperature, occurs also in this collection — a specimen from Ft. Macon, of *Spongia vermiculata*. It is one of the coarsest, most open, and aberrant forms, but is a true Spongian, and the isotherm of the surface water for January of this locality cannot be placed higher than 44° . It is also of a light color.

knowledge, the affinities of the Mediterranean forms and of many Pacific forms, with those of the West Indian regions, and the greater number of the species and varieties found there.

Several authors have remarked the susceptibility of the sponges to physical influence, notably Bronn, Schmidt, Hæckel and Miklucho-Maclay.

Bronn remarks, in his general treatise on the sponges, as follows:—“Man hat bemerkt das die näher an der Oberfläche lebenden und den Bewegungen des Wassers, des Sandes, der Steine u. s. w. mehr ausgesetzten Arten dichter von Gewebe sind, als jene aus grossen Tiefen, oder dass sie wenigstens die geschütztesten Stationen aufsuchen. Bronn, Klassen und Ordnungen d. Thierr. I, p. 24.

Schmidt, in “Spongien d. Adriatischen Meeres,” p. 40, considers that a warmer climate increases the deposit of horny matter in the skeleton of *Scopalina toxotes*. “Das südliche Klima ist dem Uebergange der Sarcode in die Hornfasern günstig; beim Verrücken gegen den oberen Theil des Adriatischen Meeres is diese Eigenschaft bis auf den Grad verloren gegangen, welcher als Gattungsmerkmal für *Scopalina* aufgestellt werden konnte.” This agrees very well indeed with my own researches, which show that the coarsest skeletons of the same species are in the warmest localities, so far as the genus *Spongia* are concerned, and it may be presumed to be true also with regard to the whole group of the *Keratosa*; but some species of *Chalinae* have thicker fibres in the northern than in the southern forms, and we cannot therefore apply it to all the fibrous sponges, as a law having no exceptions.

Miklucho-Maclay, in commenting on the remarks of Bronn and Oscar Schmidt, agrees with them so far as they show the adaptation of the species to its surroundings, and adds, “Nicht bloss die Bewegung des Wassers, sondern auch wahrscheinlich die Temperatur, der Salzgehalt, so wie die chemische Zusammensetzung des Wassers sind Factoren welche die Skelettbildung bedingen oder verändern.”

Hæckel also, in his *Calcispongiae*, frequently alludes to the modifying influence of physical causes, and all of these authorities view this influence in the same way. They regard the modifications which take place as adaptations of the organization to its surroundings. Whether the modifications are to be viewed as the direct product of the agency of the physical causes themselves, or partly to the action of Natural Selection, is not so clearly expressed by them as might have been wished.

Similar researches to that in which we are now engaged have been made of late upon terrestrial animals by several authors, and notably by Mr. J. A. Allen, of the Museum of Comparative Zoology, Cambridge. The results attained by him are so much more exact and reliable, and so nearly parallel with my own, which are merely preliminary to a fuller consideration of the subject in future parts of this Memoir, that I need make no excuse for the insertion of the following abstract of the influences of environment upon mammals and birds, which has been kindly furnished by him at my special request.

“The direct action of the conditions of habitat upon mammals and birds has recently been shown, with reference particularly to those of North America, to be very strongly marked, resulting in modifications of the general size, of the coloration, and the relative size and form of particular organs. These modifications are clearly local, affecting similarly, though not always to the same degree, all, or nearly all, the species inhabiting the same areas, so that variations of a somewhat special character become characteristic of par-

ticular geographical regions. Thus there is found to be a gradual loss of color among individuals of the same species, in passing from the heavily wooded region of the eastern half of the United States to the treeless plains, and the still more arid regions beyond the Rocky Mountains, particularly in portions of the Great Basin and the desert tracts of the Gila and Great Colorado Rivers; the most pallid tints occurring where the vegetation is most scanty, and the climate most arid, — where, in short, the protective conditions as respects color are at a minimum. On the other hand, a remarkable accession of color is seen over the heavily wooded, rainy region of the northwest coast. There is again a marked accentuation of color to the southward, accompanying increased climatic humidity and a higher temperature, these conditions evidently favoring in themselves an increase in intensity, while they give rise to protective conditions, such as luxuriant vegetation and a partially overcast sky, which favor the retention of color. It is certainly found that in individuals of the same species the various shades of red, yellow, green, blue and black, become stronger or more intensified in passing from the higher latitudes towards the tropics; that dusky and black spots and bars, or other blackish areas, increase in extent, while light areas, particularly white spots and bars, become correspondingly reduced in area; and that, at the same time, there is an increase in lustre and iridescence, in species tending to such phases of coloration. There is thus a general increase in the brightness and extent of the stronger tints of coloration in the direction of the intertropical regions, where all forms of animal life, as a rule, become most brilliantly colored.¹

“In respect to the increased size of particular organs, it is found that, especially among birds, there is a strong tendency to the disproportionate enlargement of peripheral parts in passing from the colder parts of the North America continent toward the tropics. This is particularly noticeable in respect to the bill and tail, both of which often increase in size in passing southward, either with relation to the general size of the individual, or absolutely. In birds having a short thick bill, as the finches, crows, etc., the bill becomes generally larger, while in slender-billed forms, as in some of the warblers, thrushes, wrens, the grackles, etc., the bill becomes longer, slenderer, and often more decurved. In mammals the pelage becomes shorter and harsher, with less underfur; the soles of the feet often, in great part, lose their furry covering, while in numerous well-marked instances the ears and the feet become noticeably increased in size. This may be presumably considered as due to the higher temperature of the lower latitudes favoring an increased circulation in the peripheral parts of the body, and their consequent greater nourishment. Furthermore, the increase in the size of the bill and length of the tail is in the direction of the region where these parts of the ornithic organism almost universally reach their greatest development.

“In respect to the variation in size, there is generally, in both birds and mammals, a marked increase toward the northern and more elevated parts of the continent, with a few exceptions, however, of an equally marked increase in size toward the tropics. In general terms, the law of increase in size, as modified by recent researches, may be stated as an

¹This law also applies to sponges; the brighter colored forms being generally littoral where the temperature of the water in any given locality is highest: and in the tropics there are comparatively few of the dull colored species so abundant at the north, but a prevalence of brilliant reds,

greens, and yellows, with intense shades of purple and purplish brown or black. See, also, for increase of peripheral parts and coloration of Insects, “Revision of the *Cedipodidæ*,” by S. H. Scudder, Proc. Bost. Soc. Nat. Hist., Vol. xvii, p. 482-83.

increase toward the centre of development of the species, or toward the centre of development of the group (genus, sub-family, or family, as the case may be) to which the species belongs. This increase generally amounts to from five to twenty-five per cent. of the average size of the species, but in very rare instances there is found to be no appreciable variation in size over immense areas, or throughout the entire habitat of species having a very wide geographical range. Since decrease in size so generally accompanies increase of temperature, it may be considered as possibly due to the enervating, or other unfavorable action of tropical influences upon the organism, a view strengthened by the fact that decrease in size is often accompanied by a loss of vivacity, and, in birds, a deterioration of song. In the case of the exceptional increase in size southward in North American birds and mammals, it is always found to occur in groups which attain their maximum development, both as respects the number and the size of the species, in intertropical latitudes, where of course such groups find their most favorable conditions of existence; just as increase of size northward occurs in species belonging to groups which have the greatest number of species, and those of largest size, in the colder latitudes; the increase in both cases being in the direction of the region evidently most favorable for the existence of the species.

“That the above cited variations in size, in coloration, and in the size of particular organs, have direct relation to the conditions of environment, is conclusively shown by the manner in which these variations occur. In many cases the extreme phases of differentiation presented by a wide-ranging species are so diverse that they were often formerly regarded as representing entirely distinct species, but subsequent material received from numerous intermediate localities has shown a complete and gradual intergradation between them; so that it has been found to be more in accordance with the facts to relegate many forms, formerly and, as then known, properly regarded as distinct species, to the rank of geographical races or sub-species. The passage from one extreme to the other, in any given case, is found to be as gradual as that in the climatic conditions of the two climatically very diverse regions under which these several phases reach their greatest specialization, and the majority of the species occurring together over a wide area tend to run into similar local phases of differentiation under similar conditions of environment.”

These results are far too uniform and general in their effect upon widely distinct animals to be due to Natural Selection, in fact, I entirely agree with Mr. Allen that such uniformity of result here, and in the sponges, can only be explained by the action of physical surroundings directly working upon the organization and producing by such direct action the modifications or common variations above described.

If a uniform result follows upon the exposure of a given animal, and its congeneric forms, to the action of certain physical conditions, the modifications which result must be taken out of the category of those differences which may have been preserved by Natural Selection, the proper field for which lies in the preservation of those differences which arise through a tendency to variation, and are perpetuated and preserved simply because they are of advantage to some particular animal or race. To assume that only those species survive in these fields, the Mediterranean and others, whose organization fits them to become modified in a particular way, is perhaps a fact which may be verified some day by experiment, and in so far the law of the survival of the fittest probably obtains. What I mean to point out is, that within this limit the animals are modified so directly,

so generally and so uniformly in certain characteristics, by traceable physical causes, that I cannot imagine the intervention of any other secondary cause; there is no room for a struggle, or for selection, since the uniform action of a given temperature, depth, amount of sediment, sheltered locality, etc., have a corresponding uniformity in results, and are sufficient in themselves to account for the general modifications described.

The Mediterranean also affords us an admirable test of the Wagnerian hypothesis of an isolated locality, in which distinct races have arisen through the prevention of intercrossing with the parent races or species, and should give a triumphant example demonstrating the truth of that theory. That distinct varieties may arise in the same order on the same shore, according as they grow in shallow or deeper water, in clear or muddy water, and that these differ from each other in a manner which is similar to that in which the inhabitants of distinct regions differ from each other, is a fatal objection. Again, how could it have possibly happened that all three of the Mediterranean species, with their numerous varieties, arrived at the same general result, namely, greater fineness, density and elasticity of the skeletal fibres, through the mere prevention of intercrossing with the original coarse stock. Does it not seem at once evident, that if the coarse forms of the West were the progenitors, the first settlers of the latter would have produced at once in the new region all the usual variations, and that any general change in all of these would not be, could not be a question influenced by the prevention of crossing. On the same rule, the *Chalinulæ* in any of our estuaries, ought to differ from those in every other; but they do not, unless the temperature of the water, or some other physical change, brings it about. In applying Weissmann's modifications of Wagner's hypothesis to the explanation of any of the observed phenomena, I find myself equally at a loss. According to his ideas, a species has a variable and a constant period in its life history; if the isolated colonies are formed during the former period a new species results through "amixie," or non-intercourse with the parent species; if the colony is formed during the constant period no change can take place in this way.

Variability is generally correlative with the conditions of the habitat. Upon a hard bottom, or near shore, a sponge is apt to vary in a thousand ways to suit an equal number of changes due to the accident of its situation, here or there, wherever the larva may strike a suitable surface; if it is upon a sandy bottom, like the *Suberites compacta* Verr., it has a peculiar organization, which is remarkably dense and elastic, no base of attachment, and a flattened form to enable it to rest well on the bottom and be readily covered up in storms, rather than rolled about, and washed finally ashore; if it is an inhabitant of muddy bottoms then it has the anchoring threads fastening it in the mud, and the most invariable forms, so far as the species is concerned, necessarily due to the continued influence of the uniformity of its habitat. The shallow water forms, however, differ from the deep water forms; but in the genus *Tethya*, for example, there is the same rotund erect form, with a similar radiate arrangement of the skeleton, evidently due to the necessity of anchorage downwards as well as growth upwards. I cannot, consequently, with regard to the littoral genus *Spongia*, imagine any past or present condition under which it could become constant. Even when the conditions of the habitat are completely changed, the resulting modifications evidently take place immediately in the first inhabitants. Thus during an extended series of dredging in the

steamer of the United States Fish Commission, continued during several summers in Long Island and Vineyard Sounds, and south of Cape Cod, there was found upon hard bottom but one specimen of *Suberites compacta* Verr. This had formed a base of attachment, not to the top, but to the side of a stone, and did not rise in branches, as is usual with sponges growing habitually on hard bottoms, but lay flat, as if upon its natural bed of sand. In the same way, no change beyond what is necessary, takes place in the skeleton of *Tethya*¹ when it is found upon hard bottom, as is the case upon the English coast; a base of attachment is formed, but the skeleton preserves its peculiar radiate arrangement, and the typical shape is retained. How the law of "amixie" can be applied here, or to Mr. Allen's observations quoted previously, I cannot see; physical causes alone seem to be sufficient to account for the variations, and the law of heredity, that like produces like, to account for the persistence of a similar structure in forms, which, like the two last described, have migrated from the habitat where they probably acquired their peculiar organization.

Again, according to Weissmann's ideas, when a number of varieties enter a new and isolated territory, those varieties can only produce a new form varying from the parent species in the same way that they, as a whole, vary from the parent varieties as a whole. Thus if the wanderers include many aberrant forms having a large majority of individuals, the result of their crossing, when isolated together, would be a new aberrant form. It would not be at all probable that these species would enter a new locality with precisely the same, or even a similar assemblage of forms, and produce by "amixie" the same, or a similar result; but this is what must have been done in the present cases.

These remarks and criticisms are applied strictly to the characteristics which have been analyzed, and it is quite possible that when the anatomy, coloration, etc., come to be studied, that results confirmatory of the conclusions of Weissmann may be obtained, but the presumptions are now strong against this, especially in view of Mr. Allen's conclusions, which deal with the same class of external characteristics so fully studied by Weissmann among the insects.

I might also produce here, if it was essential to a clearer understanding of the subject, instances among the fresh water Polyzoa which are no less responsive to physical influences in certain important characteristics, but this is probably unnecessary. What I particularly wish to point out, and in so far, agree with Weissmann and several other evolutionists, is this, that there are certain characters in every species, which, though presenting many variations of a definite kind, do not arise through Natural Selection, and that naturalists who apply that law without carefully studying, not only what may be due to physical causes but to the tendencies and characteristics inherited from the ancestors of the group or species, are not likely to attain results which will add so much to the knowledge of philosophical zoology as if they had taken this side of the question into consideration.

The following observations were made upon the larvæ of several specimens preserved in alcohol, and though necessarily very imperfect, they are important, and seem to establish the following propositions.

¹ *Tethya gravida*, sp. n. Loc. Buzzard's Bay, is a new species found growing on mud in shallow water, and sustained by a base of loose fibres, which like a net catch and hold

pebbles and sand sifted out of the mud, and, thus ballasted, the animal is held upright under all circumstances. See also Johnson's Encyclopedia, article Sponges, by A. Hyatt.

First, that the development of the genus *Spongia* resembles that of *Chalina*, which has been studied by the author, and that of the *Halicondrida* as expounded by Barrois, in all its principal characteristics, except the entire absence in the early stages of any signs of a skeleton, either in the form of threads or spicules.

Second, that, as far as known, the development is very similar to that of the *Aplysine* form, *Verongia rosea*, as studied by Barrois; but the basal collar and area, which play so prominent a part in the development of the genus *Chalina*¹ and the siliceous sponges, are also well developed in these larvæ, whereas they are less noticeable in *Verongia*.

Third, that the *Spongina* are by these characteristics of the larvæ distinctly separated from both the *Aplysina* and *Chalina*, and therefore rightfully occupy the intermediate place to which the structure of the full grown skeleton has hitherto caused them to be assigned by authors.

Fourth, that the sub-orders of the *Keratosa*, as far as known, are more easily distinguished in their early stages, in their larval than in their full grown forms, and that the assumptions drawn from the adult skeletons that the larger groups, such as the *Aplysina*, *Spongina*, *Chalina*, etc., run together through the structure of their adult skeletons, may perhaps be founded upon errors of observation, which will be corrected by more prolonged and thorough researches upon the differences in the mode of development of the similar structure exhibited by the fibres in these different groups.

This last position is not only supported by Barrois' observations on *Verongia*, showing that this genus of the *Aplysina* has a larva with the basal collar and central area much flattened; by my own observations on the *Spongia*, showing that the larvæ have a prominent basal collar and area, but no skeleton; and by my own unpublished camera drawings of the larvæ of two species of *Chalina* exhibiting the basal collar, area, and the skeletal spicules in the interior of the endoderm, with their bases showing below as bright points in the basal area; but also by the observations of Barrois and Carter, upon the development of *Halisarea*, which evidently does not belong to the *Keratosa*, since it is very distinct indeed from all the preceding.

In one alcoholic specimen of *Spongia agaricina*, sub-species *corlosia*, the egg at an early stage was found to consist, as in all other sponges, of a large cell, with nucleus and nucleolus. Each egg was surrounded by a clear transparent membrane, and nearly filled the middle of the ovarian capsule thus formed. As it increases in size the yolk becomes opaque and granular, obscuring the nucleus and nucleolus. Unfortunately the state of the specimens did not permit the mode of segmentation to be seen. Later stages of larval growth resembled those of *Spongia graminea*.

There was also only one alcoholic specimen of *Spongia graminea* in the Palmer collection containing larval forms. The earliest stage observed was considerably advanced. The process of segmentation was fully completed, and the division of the body of the larva into two regions had taken place. The interior appeared to be, as in the siliceous sponges at this period, entirely filled by minute granules, and the external membrane also, as in the siliceous sponges, to have become converted into long, cylindrical cells, but whether they were flagel-

¹ In this connection, I shall at present confine myself to mere statements, simply adding that I have ample evidence of the fact as stated, and have also been engaged for some

time past in studying the sponges of the New England coast, and hope to give the results of my observations on *Chalina* and *Isodictya* in the next part of this Memoir.

lated or not, could not be seen in specimens so long preserved in liquor. On one pole of this larva there was a circular space of variable size loaded with dark pigment, and made up of apparently larger and rounder cells, at least that was their external or superficial aspect; they were not seen in section. This area became more definitely restricted and more symmetrical in outline in the next stage, and finally a distinct constriction separating it from the rest of the larva became visible. About the same time, or even previous to this, in some specimens a clear, round space appeared in the centre of this area, which I shall for convenience sake call the "basal" area, and the darker zone about it the basal collar. In the next stage a constriction or depressed line separates the basal area from the collar, which then stands out as a distinct raised ring, somewhat depressed along the central line by a slight sulcation in most specimens, but not in all. Sometimes the basal area in these alcoholic specimens is depressed considerably below the surface of the basal collar, but more frequently it is considerably raised above it, and this seems to be the normal condition at all stages.

The most curious folds take place in the larva from the contraction of the ectoderm, so that I was completely deceived into the belief that they represented the earliest stage of the development of the complicated fibrous skeleton in the first specimen I saw, which happened to be one with very symmetrical folds, or rather channels, on the surface. The larva at this stage is still surrounded by the thin hyaline membrane previously noticed, and when three or more are close together this capsular membrane becomes a prominent feature. The cells composing it are of large size, in diameter about equal to the length of the ectodermal cells.

After the appearance of the pigment at the basal end, sometimes before the collar is formed, and in some cases subsequently, a similar gathering of pigment is observable at the opposite pole. Then probably at an equally variable succeeding period, the cells at this extremity take on the rounded aspect externally of those of the basal collar, and the ectoderm becomes decisively thinner at this place. I saw this in only one specimen, but it happened to be a remarkably fine and unusually transparent form, showing the fully developed basal collar and basal area. There was no aperture visible at this point, which might be called the cloacal pole, though the central cells of the ectoderm were distinctly visible.

It will be observed that these cursory observations are strongly confirmatory of those made by Barrois upon his *Verongia rosea*, but not of his *Gumminea? mimosa*, the young of which resemble more closely those of true Halisarea, as figured by Carter and observed by Barrois and Carter, and have a significant resemblance to the young of the Calcispongiae.

The observations of Barrois upon *Verongia rosea* show about the same stages of development as those of *Spongia* described in this paper, with the exception of his fig. 39, which, as one of the last of the simple stages of segmentation, was not observed by me. My observations have led me to regard the skeleton of the Keratosa as the product primarily of the ectoderm, and those of Barrois previously quoted sustain this view. The stages observed by me in *Spongia graminea* and *corlosia* correspond to Barrois' figs. 23, 27, 28 of the siliceous sponge on his Pl. 15, and his figure on Pl. 14 of *Verongia rosea*, corresponds to fig. 26 of Pl. 15. It is subsequently to this that the basal collar and area are formed, and that the larva of *Spongia* assumes characteristics similar to those of the larva of *Chalinula*, and some other siliceous sponges of the true Halichondrida observed by me at Eastport, Maine; but in none of the species of the siliceous sponges examined did I wit-

ness the determination of the pigment particles to the opposite or cloacal pole, as described by Barrois. This coloration has been seen by Barrois, however, in his *Verongia rosea*, and the area is figured as a bare space, Pl. 15, fig. 41, and has been observed by Carter, Barrois and myself, in several different species of the true siliceous sponges and Chalinulæ, as a bare projecting knob at the cloacal pole, which invariably appears to be imperforate.

DESCRIPTIONS OF GENERA AND SPECIES.

SPONGIA Auct.

Euspongia Bronn. *Caccospongia* Schmidt.

The skeleton is composed of solid elastic fibres. The structure is irregularly radiatory. The primary fibres, those having their origin in the external integument, are usually though not invariably more or less radiatory, but the secondary, or connecting fibres, are excessively irregular, and generally very closely intertwined. The primary fibres are particularly noticeable on the inner side of the walls of the excurrent openings. A very regular structure of the skeleton is found more or less in the walls of the larger cloacal canals and in the young of nearly all species, and in the adults of some undoubted specimens of *Spongia*, but, as a rule, there is no very definite arrangement, like that in *Spongelia*. The specimens, however, in which a radiatory arrangement of the primary fibres cannot be detected, are exceptional among the Florida sponges, though perhaps not so common as among the Mediterranean forms. The skeleton exhibits a very rough surface. This is due to the development of large projecting masses of the secondary fibres, which are separated by horizontal channels of greater or less depth. The primary fibres protrude above the surface of the cushions or ridges thus formed, carrying with them more or less of the secondary fibres, and forming a series of sub-dermal or superficial tufts, giving the skeleton a peculiarly hirsute aspect. In some sponges these, like the cushions or ridges, are absent, though I have failed to find any of this genus in which both have been wanting; *i. e.*, a specimen with a perfectly smooth, even surface.

This structure of the surface, when it is covered, as in the living state, by the external membrane, gives a very peculiar aspect to the subdermal region. This appears to be undermined with innumerable holes and channels, which open below into the water system, and externally by means of pores through the dermal membrane. These pores are very numerous, quite permanent in their position, and though irregularly scattered over the sides of the mass, often remain open even in dried specimens. The cloacal canals are few in number but exceedingly large, and the interstitial canals very numerous and not comparatively very small. The large excurrent apertures are irregularly scattered about, but almost always on the upper side of the colony.

The dermal membrane in a living condition is of a dark brown or very dark purple or black color. The external layer is usually more or less filled with whatever sediment may be prevalent in the water, and, especially in the West Indies, with the siliceous spicules of other sponges. A sort of selection also appears to be exercised in favor of the simplest and finest forms of spiculæ, which I presume are more abundant in the surrounding water. These, together with minute fragments of stone, pass into the substance of the primary fibres, which are rarely free from such impurities. The secondary fibres, owing to their mode of deposition within the ectoderm are, however, always clean.

In describing the species of this genus I have made comparisons between three principal Mediterranean, and three of the American commercial sponges, in order to show the very evident relationship of these forms. Schmidt describes five Mediterranean species in all, and may be right; but so far as I can understand his descriptions, with the aid of a fine collection of specimens purchased by Prof. Baird for the National Museum, from Mr. Isaacs of New York, I cannot make more than three out of the ordinary commercial varieties, which were fully represented and appeared to include the entire range of his five species. Von Eckhel's work upon the "Badeschwämme," although a purely commercial treatise, has the same view of the affinities of the sponges, based upon the observations of the fishermen and dealers, and the distribution of the species; the latter is quite remarkable. Only one species, the *Spongia officinalis* Linn., *Adriatica* Schm., is found on the eastern shore of the Adriatic and coast of Greece, from Trieste to the Bay of Nauplia. From Nauplia and the island of Candia to Eritra, on the coast of Asia Minor, two occur, *Spongia officinalis* and *Spongia agaricina* Pall., *Zimocca* Schm. From Eritra, opposite the island of Chios, to Tripoli, all three, *Spongia officinalis*, *agaricina* and *equina*, are fished, except at the island of Cyprus, where the *Zimocca* sponge does not live. From Tripoli to Tunis two only occur, *Spongia officinalis* and *equina*, and from thence to Ceuta at the Straits of Gibraltar, a very peculiar, dark colored and coarse variety of the *Spongia equina* is obtained, called the Gerbis sponge.

This distribution indicates the naturalness of the three species, and shows also that the dealers have to do with a vast variety of forms. They can, however, pick out the three species and their varieties without hesitation, and I was amused and interested at finding that the method pursued was precisely similar to that which I had been obliged to adopt in distinguishing empirically the various sub-species and species of *Spongia*. They are led mainly by the general aspect of the surface. This has a distinct appearance in every species, and though much altered by the greater or less development of superficial tufts, is much more constant than any other character. This is due to the fact that the surface takes its aspect largely from the number, distribution and size of the pores, cloacal orifices, superficial canals and primary fibres. These characteristics, of course, are directly correlated with all that is important in the internal anatomy of the animal, and should therefore be more constant than the length, form or composition of the tufts of fibres, or the shape of the whole, which are capable of great modification, according to the locality in which the specimen may be found. The forms of *Spongia officinalis* may vary from cup-shaped to fistular, and to irregular or lump-like. The latter are usually coarser and looser in texture, the superficial tufts are longer and more numerous, and they approximate more closely to the coarser varieties of sub-species *tubulifera* of the Carribean Sea in the external aspect of the surface and the apertion of the interior, than the finer varieties.

The texture of the poorest variety of the Mediterranean sponges is, however, always better for domestic purposes than the best of the corresponding American varieties, being firmer and more elastic; and it is also to be remarked, that the last never have the cup-shape, which is so common in the sub-species *Mediterranea*, and that the fistular form takes its place. The forms of *Spongia agaricina*, sub-species *Zimocca*, vary from saucer-shaped to irregular lump-like growths. As in the *Spongia officinalis*, it may be shown that these aberrant forms are quite similar to the aberrant or formless varieties of the sub-species *punctata* of Florida, as regards the aspect of the surface; but these also are nevertheless much

finer than the finest varieties of the latter. Here, again, the platter or saucer-shape, which is a modification of the cup-shape, is absent. *Spongia equina* exhibits similar degrees of variation in the texture of the surface and the form. There are no proper cup-shaped specimens among the American varieties of sub-species *gossypina*, but in place of these the fistular form. These occur generally associated in clumps, more or less densely filled up into heads, and solid, but sometimes the tubes are almost isolated, as in the specimen figured, Pl. XVI, fig. 7. The younger specimens of this species have a very loose and open texture, due to the approximation and large size of the openings, and to a less degree this is also to be remarked in the Gerbis sponge. The former approximate in aspect to the coarser qualities of the American species, and so also does the latter, which has very nearly the same color and aspect as the dark colored Key West specimens, but is not so coarse or dark. It seems, then, that there are three sub-species of commercial value in the Mediterranean, and although there are more than three in the list of the American forms which follows, there are really only three, or at most four, sub-species, which find their way into the New York and European markets. The coarsest varieties of the European sponges are finer, firmer, and more elastic than the finest of the corresponding American sub-species. This is directly traceable to the larger amount of foreign matter included in the primary threads, the looser mesh of the tissue; the fibres are also comparatively coarser and the large cloacal channels more numerous throughout the mass. Nevertheless we can select specimens which it would be difficult to distinguish, such as the fragment, Pl. XVI, fig. 1, taken out of the side of a large Florida or Nassau sponge, of such exceptional fineness that only the very loose texture, form, dark color, and collection in which it was found, enabled me to separate it as an undoubted Carribean form. Compare this with fig. 8, and also compare fig. 16, a piece from the side of an old specimen of a Carribean form of sub-species *tubulifera* with the under side of fig. 18, a true cup sponge from the Adriatic of rather coarse quality. There is precisely the same sort of relationship here as I have observed between the different qualities of sponges existing in the same seas. Thus the different varieties of sub-species *gossypina* differ in an exactly similar way from each other, and from the third form, sub-species *cerebriformis*. They differ in texture, in surface, and also in habitat, the finer kinds, as stated previously, being found in the deeper water, equally removed from excessive heat and excessive sediment. These three sub-species run together by means of specimens of the coarser varieties, which cannot be distinguished from each other with any certainty, in the same manner as the corresponding sub-species in the Mediterranean and Carribean Seas were connected, through the coarser, and not by the aid of the finer varieties. It is evident, however, that besides the general differences noted on previous pages, that the cup-shaped form is not found in the American sub-species, whereas it is the prevalent form of the Mediterranean sub-species. A cursory examination of a large collection will, however, satisfy any one that the shape does not necessarily correlative with a finer or a coarser skeleton, but probably with a more or less extended base of attachment and local peculiarities, such as currents, and the kind of bottom, etc., which have not been investigated in this connection.

In order to obviate the technical difficulties attending the labelling of specimens according to the trinomial system, it has been suggested to me that the sub-species name should be inclosed in brackets, thus, *Spongia officinalis* [*tubulifera* D. et M.] Linn., var. *rotunda*. To this, however, though it would as completely represent the true affinities of the sponges

as is perhaps possible, the objection might be made that it is altogether too cumbersome for the purpose of labelling collections for exhibition in Museums, and might lead to some confusion in the use of the names here proposed. I therefore append a list below, made out according to the usual method, every sufficiently distinct form being labelled as a different species, so that one may have a choice.

- Spongia officinalis* Linn. = $\left\{ \begin{array}{l} \textit{Spongia Adriatica} \text{ Schm.} \\ \text{ " } \textit{Quarnerensis} \text{ Schm.} \end{array} \right.$ = sub-species *Mediterranea*.
- " *mollissima* Schm. = variety *mollissima* (Levant sponge and Turkey Cup).
- " *tubulifera* Duch. et Mich. = species *tubulifera*.
- " *discus* Hyatt.
- " *lignea* Hyatt.
- " *graminea* Hyatt.
- " *equina* Schm.
- " *gossypina* Duch. et Mich. = sub-species *gossypina*.
- " *meandriniformis* Duch. et Mich. = sub-species *meandriniformis*.
- " *cerebriformis* Duch. et Mich. = sub-species *cerebriformis*.
- " *agaricina* Pall. = *Spongia Zimocca* Schm. = sub-species *Zimocca*.
- " *dura* Hyatt = sub-species *dura*.
- " *punctata* = sub-species *punctata*.
- " *corlosia* Duch. et Mich. = sub-species *corlosia*.
- " *vermiculata* Duch. et Mich.
- " *Cookii* Hyatt = sub-species *Cookii*.
- " *molliata* Hyatt = sub-species *molliata*.
- " *lapidescens* Duch. et Mich.
- " *dentata* Hyatt = sub-species *dentata*.
- " *Mauritiana* Hyatt = sub-species *Mauritiana*.
- " *tectoria* Hyatt = sub-species *tectoria*.

I have found myself entirely at a loss in the attempt to use the microscopical structure and arrangement, or size of the fibres in the descriptions of the species and varieties. The number of illustrations necessary in order to show the variations in one single colony, and in any one of the better represented species would have filled several plates. The expense and doubtful utility of attempting to delineate fully, structures so evidently subject to local modifications, and the necessity of a strict economy in the Society's publications, caused the abandonment of all figures of the skeletal structure in order to secure a more complete representation of the constant characteristics of the external surface.

The series of slides, however, prepared by Mr. Crosby, Assistant in the Society's Museum, and myself, represent many varieties, and from these, and others of a more temporary character, have been taken the remarks with regard to the microscopical structure of the skeletons which accompany the specific descriptions.

Spongia officinalis Linn.

Spongia officinalis Esper, Pflanzthiere, vol. 2, pl. 15.

Sub-species **Mediterranea**.

Variety *Adriatica*.

Spongia Adriatica Schm., Spong. d. Adriatish. Meeres, p. 20.

Spongia Quarnerensis Schm., *ibid*.

This variety, Pl. XVI, figs. 18, 19, has a somewhat coarser texture than the true Levant and Syrian varieties, which have a denser mesh and finer fibres. The forms vary from those which are typically cup-shaped to a flattened Zimocca-like form, or to a mere aggregate of fistular branches, which are generally more or less closely associated. The typical or cup-shaped form is often open on the side, or even varies to an almost solid form, with the excurrent orifice gathered into a hollow at the top. The fibre is fine and close and soft to the touch, the tufts of the surface very small. It is prevalent in the Adriatic Sea, according to Von Eckhel, and becomes identical farther south with the fine textured typical Turkey Cup sponge, and the finest of all sponges, the Levant Toilet sponge, both of which are included under the name of *mollissima*.

Variety *mollissima*.

Spongia mollissima Schm., *Op. cit.*, p. 23.

This variety, Pl. XVI, fig. 21, may be either cup-shaped or more or less solid, differing from the other varieties simply in the fineness and extreme density of the closely woven fibres. It was probably this which led Schmidt to separate it as a distinct form, but there are intermediate varieties, which show that this is an incorrect conclusion.

Variety *tubuliformis* (Pl. XVI, fig. 20) may be either cup-shaped, or more or less of a solid form, either lobed or fistular, but in all specimens the superficial bundles of fibres are very long and numerous, giving the edges of excurrent apertures and the whole surface a very hirsute aspect.

Variety *zimocciformis*. It may be well to describe another variety in which the peculiar aspect of the upper surface and the typical saucer-shaped form of the *Spongia agaricina*, sub-species *Zimocca*, is so closely imitated that some specimens might be mistaken for that species, but in others the whole upper surface becomes flattened and table-like, and very dense and smooth.

The more solid specimens of variety *tubuliformis*, especially those of irregular shapes, approximate in the young to the most open and least useful varieties of the Florida sponge, sub-species *tubulifera*. I cannot see, since Dr. Ehler's paper, why it is either necessary or proper to hold to Schmidt's name of *Spongia Adriatica*. It was correct, so long as the Esperian sponge was unknown, to drop the old name, which by too general application had become useless, but now that we can return to this and give it an exact meaning, it becomes essential to retain it.

Sub-species **tubulifera**.

Spongia tubulifera Lam., Anim. sans Vert., vol. ii, p. 363, 2d Ed.

Spongia tubulifera Duch. et Mich., Naturk. Verhand. Hollandische Maatsch. Wetensch. Haarlem, 2 Verz. 21, 2, p. 34, pl. 4. 1864.

If any reader wishes to compare this variety as a whole with the sub-species *Mediterranea*, he will do well to contrast fig. 15 with fig. 21, fig. 13 with fig. 19, fig. 10 with fig. 20, and especially fig. 16 with fig. 18. In every case these figures occur on Pl. XVI, and the

first mentioned refers to a specimen of sub-species *tubulifera*, and the second to the corresponding quality of sub-species *Mediterranea*. It will be observed that the divergence is greatest both in form and texture in the finest quality, figs. 15 and 21, and that the approximation of the varieties occurs in the lower or less regular and coarser forms, such as figs. 10 and 20, and still more closely in figs. 16 and 18. The first of these last is a fragment of an old specimen of *tubulifera*, and the last is the surface of a very coarse specimen of *Mediterranea*.

There are several prominent variations in the mode of arrangement of the fibres when examined by the microscope, of which the following are perhaps the most remarkable.

1. The primary fibres single, continuous, projecting, stout. From the terminations of these hang festoons of secondary fibres, forming the superficial, interstitial skeleton.

2. The primary fibres either single or treble, and more or less continuous below as a sort of closely woven fascicle.

3. The primary fibres project in a fascicle of two, three or more, but are deflected laterally below, and are not continuous in the body of the skeleton as vertical fibres. Their presence is indicated below by a denser mesh of fibres surrounding a continuous, or nearly continuous, and somewhat tortuous track of debris. The mesh of connecting or secondary fibres is proportionally about equal in length and breadth in all the specimens examined.

This sub-species has, as compared with other American sub-species, a skeleton composed of remarkably fine fibres, which bleach out to a whitish brown color. The surface is covered with fine tufts of primary fibres which are, however, very pliable. The surface is generally quite free from cushions and ridges, and the channels between these when they do occur, are neither very deep nor long. The result of these characteristics is a form with a smoother surface and a denser looking skeleton than usual, pierced on the sides by numerous small apertures very regularly distributed, and at the top by one or more large cloacal oscules. The form is generally dome-like, and is never, so far as I know, cup-shaped, though it may become exceedingly irregular, fistular, or even dendritic.

The older specimens show a decided tendency to increase by the prolongation of the parts immediately around the apertures. Thus the main body of the sponge becomes projected into numerous smaller conical or head-shaped masses, like the young of variety *rotunda*, and crested masses like those of variety *disciformis*. At an advanced age the fibre becomes very brittle, and unfit for domestic purposes.

Dr. Palmer reports that this species is found generally associated in considerable numbers, not often growing either upon other sponges or upon corals, but generally upon hard bottom. Color while living is black, and the largest seen was about eight inches high by about twenty in circumference.

Loc., Key West, Nassau. Habitat, hard bottom or reef in six feet of water.

Variety *pertusa* (Pl. XVI, fig. 11-11a). The colony in this variety is composed of several fistular elevated orifices of the ordinary density of texture, but united by a depressed portion of extremely porous structure. The secondary tufts or pencils are of extraordinary length upon the flattened central portions. Under this head is included a number of forms in which the fistular orifices are numerous. These being more closely approximated than in other sub-varieties, this intermediate depressed portion disappears, and the sponge acquires the characteristics of the next variety.

Variety *mollis* (Pl. XVI, fig. 12). The skeleton is perforated by many large canals opening through the upper surface, the tissue between is also very porous, and the aspect is that of a number of fistular sponges united into a more or less complete head.

Loc., Nassau, in Soc. Coll., and Havana, Island of Noronha, Province of Pernambuco, in Coll. Mus. Comp. Zoology.

Variety *prava* (Pl. XVI, fig. 17). This variety is similar to the preceding in most of its characteristics, but differs in the entire suppression of the projecting apertures and the smoothness of the surface, broken only by numerous superficial canals.

Variety *disciformis*. This is, properly speaking, perhaps one of the typical forms, since the texture is throughout like the best quality of commercial sponges. It may have only one or two large apertures, or it may have several, but they are mostly arranged in a row along the crest of a flattened or helmet-shaped sponge. Its resemblance to *discus* is limited to this characteristic. It may possibly be identical with *Spongia musicalis* Duch. et Mich.; the surface appears to agree with that of their drawing. Other specimens, however, which might be best referred to this variety, have not only the helmet shape, but are distinguished by the presence near the oscules of fringe-like tufts. Others, again, have the prominent tufts of primary fibres over the whole surface, with the form of *rotunda*.

Variety *rotunda* (Pl. XV, fig. 1; Pl. XVI, fig. 15). In the young this variety may have a conical form, with only one fistular orifice, but generally, either at an early period or later in life, there are several orifices. The rotundity of the form becomes more marked in proportion to the number of these. There are also all grades of full grown forms: those which are almost conical, with only two or three orifices, like the young just described; those in which the top is almost round; and those with series of sunken apertures dividing the top into radiating ridges, with more or less deeply marked depressions between. The apertures in the round solid heads are not only apt to be more numerous, but also smaller than in any of the other forms.

Variety *aperta*. This is precisely similar to the rounded and firmest specimens of the preceding, and like that may have apertures which are either small and numerous, or larger and more sparsely distributed. The interior, however, is cut through by huge channels, which render its solid aspect a mere sham. These channels, or open galleries, penetrate frequently in every direction, anastomosing with each other, and finally opening somewhere upon the sides. They are not to be confounded with the apertures, since they are mere galleries through the substance of the sponge, and are lined by the external membrane.

Variety *corlosiformis* (Pl. XVI, fig. 14). This name is given in allusion to the form, which has the flattened aspect above, and general outline of variety *corlosia*, but otherwise it does not resemble that species. The colony is in some specimens cavernous, as in the preceding variety; in others it is solid, the apertures, however, are generally larger, as in the more conical specimens of variety *rotunda*.

Variety *duplex*. This variety is caused by the growth of several long, thick, solid branches, making a peculiar dendritic form. The orifices are large, and situated on one side. The texture of the single specimen examined was a little coarser and darker than is usual in this sub-species.

Loc., Havana, in Coll. Mus. Comp. Zoology.

Variety *exotica* (Pl. xvi, fig. 13). Differs from the preceding merely in its long fistular orifices closely approximated, or nearly completely separated.

Loc., Nassau, in Soc. Coll.

Variety *solida* (Pl. xvi, fig. 10). This is part of a larger specimen preserved in Ward's Museum, Rochester, N. Y. The branches are solid, as in variety *duplex*, and also have the cloacal apertures on the sides, but are palmate or flattened in form instead of rounded. The surface is rather smoother than in most varieties, except *rotunda*.

Spongia discus D. et M.

Spongia discus Duch. et Mich., Op. cit., p. 37.

The specimen figured (Pl. xv, fig. 3) so closely corresponds with the description given by Duchassaing and Michellotti, especially with regard to the surface, that I have thought it best to retain their name. If these authors had not given it a distinct name I should have doubtfully referred it to sub-species *tubulifera* as a variety, though I know of no variety which presents so marked a departure from the type of its species in the aspect of the surface. The comparison made by these authors between the surface of specimens dried with the epidermis remaining and the channeled surface of worm-eaten wood, is remarkably good, and it can be separated from sub-species *tubulifera* by the spinous look of the tufts of primary fibres, and the greater stiffness and dark purplish color of the skeleton.

Loc., Nassau, in Soc. Coll.

Variety *anomala*. This curious form appears to agree in all respects only with *discus*, of which species it is certainly wisest to regard it as a variety. The colony is composed of an irregular assemblage of fistulose sponge masses, extending in an irregular manner over the corallum to which it is attached. The whole is about six inches long, three inches in height at the deepest part, and about three inches thick. The central portion is made up of a line of four or five large apertures elevated upon a sort of crest which appears to be composed of a number of fistulose masses formerly separate, but now welded together. On the sides, and more or less intimately united with these, are two fistulose branches. The color is purplish, as it is also in the dried specimen of the typical *Spongia discus* just described, and the locality is the same. The surface has not that worm eaten aspect which distinguishes the surface of the typical form, but it approximates to that condition. That is to say, it has larger secondary tufts of fibres than sub-species *tubulifera*, and otherwise resembles *Spongia discus* in the generally rough irregular aspect of the surface.

Loc., Nassau, in Soc. Coll.; Havana, in Coll. Mus. Comp. Zoology, and Bermuda, in Coll. Acad. Nat. Sciences of Philadelphia.

Notwithstanding these very distinct characteristics, I describe *Spongia discus* as a distinct species with considerable doubt, feeling that it may, with more evidence, prove to be merely a variety of *tubulifera*. This doubt has been much strengthened by the receipt of another Bermuda form, a fragment of which was recently forwarded me by Mr. Goode. This has an aspect more closely like *tubulifera* than any of the above, though the skeleton is still very dark colored and very coarse.

Variety *Nicholsoni*. This variety is very similar in the aspect of the surface to the typical form, but has a coarser fibre and stiffer skeleton when dried. The color of the skeleton varies considerably from a dark purplish brown to a very light brown. The aspect of this variety approximates remotely to *Spongia graminea*, and leads the observer to think

that they can be joined; this, however, is not the case, and the resemblance disappears upon close comparison.

Loc., New South Wales, near Sydney, in Acad. Nat. Sciences, Philadelphia and in Soc. Coll.

Variety *Auklinensis*. This remarkable variety spreads out into flat masses with projecting orifices, more or less fistulose, and branches. The whole surface is exceedingly hairy, owing to the number and length of the bundles of projecting primary fibres. These are, however, similar to the more scattered ones of variety *Nicholsoni*, and the surface otherwise resembles that species.

Variety *ligneaformis*. This variety is so named because the skeleton is considerably denser than in the two preceding varieties, the tufts less spinous and smaller, and all the apertures smaller and more numerous. The fibres of the skeleton are also finer and more densely woven together.

Loc., Florida? in Coll. Acad. Nat. Sciences of Philadelphia.

***Spongia lignea* Hyatt.**

This species has the densest skeleton with the closest texture of any known sponge. The fibres are quite fine, and the whole so hard that it cannot be compressed by the fingers. The largest specimen I have seen exists in the collection of the Academy of Natural Sciences, Philadelphia. This is very much cut up in the interior by large channels, but feels as if made of cork, or wood. Unfortunately, it is much beach worn, so that the original surface could not be studied.

Loc., New South Wales, near Sydney, in Coll. Acad. Nat. Sciences of Philadelphia.

The following varieties are closely allied to the preceding, and are probably the same, but I have not the material to determine this question with certainty.

Variety *levis*. One specimen from the Collection of Yale College, United States Exploring Expedition, locality Pacific, exhibits a surface almost devoid of the projecting tufts, owing in some measure probably to attrition on the beach. Where the surface has been left entire in the hollows, the tufts are present, but not abundantly developed. The texture is excessively dense, and the surface reminds one strongly of that of sub-species *tubulifera*. This is owing to the immense number and small size of the incurrent, and the paucity of the excurrent apertures.

Variety *arborescens*. There is one of the branching specimens exhibiting many of the superficial and textural characteristics of this species, which belongs to the Collection of Yale College, locality Pearl Island, Panama Bay. It seems closely allied to variety "*levis*" in every respect except the branching form.

Variety *crassa*. A specimen from Bermuda, in the Peabody Academy Collection, has been referred also with some doubt to this species. It is very similar in most respects, but the fibres are quite dark colored, and the secondary tufts stiff and rather short; otherwise the surface and general aspect agree with those of variety *levis*.

A specimen from Mauritius, in the Collection of the Museum of Comparative Zoology, may possibly belong to this species. The texture is, however, quite similar to that of sub-species *Cookii*, "*var. vermiculatiformis*," while the surface is perhaps more like that of the typical variety of this species. There are here and there large oscules, four or five millimetres in diameter, with numerous smaller ones irregularly scattered between them. The mesh is rounded, or cellular in aspect, and quite spongelia-like on the surface. The

surface is covered in part by fringes having the branching form of those figured by Duchaussing and Michelloti, as characteristic of this species. There are also two other specimens which exhibit a similar surface from the same locality, one of them a young colony with a smoother surface and somewhat softer than is usual in large specimens.

Variety *Hawaiianensis*. One specimen from Hawaii, West Coast, exhibits the peculiar surface of this species, and its characteristic skeletal structure, but is much coarser than any other form.

***Spongia graminea* Hyatt.**

This (Pl. xv, fig. 2) is one of the "Grass sponges" of commerce, and is perhaps one of the least variable of all the species. The general description given by Duchaussing and Michelloti for *Spongia utilis*, might at first sight appear to apply to this sponge, as it might indeed to almost any of the group; but there is one remark which enables me to determine the question of identity. "Des oscules superficiels très-nombreux et ayant à peine une ligne se présentent sur tous les points de la surface supérieure, mais cependant de préférence sur les parties les plus saillantes." This last word is decisive, since in this sponge the situation of the apertures in the depressions between the lobes or ridges is especially constant and characteristic.

The general texture is coarser than in variety *tubulifera*, and the interior is exceedingly open, owing to the large size and central situation of the efferent canals. The form is that of a truncated cone, fluted by deep furrows on the sides, and either infundibuliform or flat on the truncated surface. The large excurrent orifices are all upon this surface, or in the depression which takes its place. The smaller apertures are situated on the sides, invariably in the depressions between the ridges. The persistency of the form and of the lateral ridges and the situation of the different kinds of orifices, are by far the most characteristic features of this species. Notwithstanding these facts, and though I am obliged to describe this, and some other forms, as distinct species, I have great doubts of the truth of the assumption. It rests upon the evidence of many specimens, but they are all from one locality. It is very likely that this and *Spongia discus*, and perhaps even *Spongia lignea*, will be found to have intermediate forms. I have also recognized indications of an approximation to sub-species *corlosia*, but the material at my command is not abundant enough to settle these questions satisfactorily.

This species has very singular fibres in the skeleton. The primary and secondary are of nearly equal size and very light colored in a cured skeleton. The mesh is irregular in shape. Even the secondary fibres were not free from debris in the specimen examined, and in some parts of the same it was impossible on account of the absence of the usual core of debris to pick out the vertical fibres.

It is reported to be very abundant by Dr. Palmer, growing on reefs, and generally associated in considerable numbers. They may grow on smooth bottoms, or attached to corals or to other sponges; a somewhat remarkable peculiarity. The color is black in the living. Those in our collection were found in three feet of water. There is one about seven inches in height to about five and a half inches in diameter, but they are said to grow to twice that size in deeper waters.

Locality, Key West. Habitat, reef three feet and deeper. Soc. Coll.

Spongia equina Schm.

Spongia equina Schm., Spongien d. Adr. Meeres, p. 23, pl. 2.

This species more closely resembles our ordinary forms of West Indian sponges than any other European species. The form may vary considerably, but is remarkably and constantly solid in the specimens offered for sale, and semi-globular in form. The color of the fibre externally, and the tufted surface, shows the same close approximation to the corresponding American forms of the sub-species *gossypina*, as was noticed in the preceding species. It has a similar openness, being a net work of large excurrent orifices closely approximated and fringed with prominent bundles of superficial fibres. These characteristics are also particularly marked in the young, especially in those varieties which grow laterally into flattened forms. Compare for purposes of identification, Fig. I with Fig. 8, Pl. XVI. The first is a flat variety of a Mediterranean sponge, and the latter a fragment cut out of the side of an aged specimen of sub-species *gossypina*, of remarkably fine texture. There is here evidently a fact of the same nature as that previously noticed in the comparison of the Mediterranean sub-species of *Spongia officinalis* with the American sub-species; the approximation in each case is made by means of the inferior qualities, the aberrant forms. Or if the comparisons are made between the stage of growth of any single colony of the American sub-species and the coarser kinds of the Mediterranean sub-species, the closest approximation is obtained by comparing the old age of the American sponge with the full grown of the European. This is due to the fact that the American sub-species loses in old age the tufts, or prominent pencils of primary fibres which are so numerous in the adult colonies.

The Gherbis sponge (Pl. XVI, fig. 9), a "sort" which occurs between Tunis and Ceuta, has a darker color and coarser fibre than the more eastern varieties. This color and the aspect of the surface make them very similar to the American, especially the Key West forms of sub-species *gossypina*, and this resemblance is rendered even more exact by the structure of the superficial bundles of fibres, which are much broader and more loosely connected than is usual in the Mediterranean sponges, giving the surface of some specimens a precisely similar aspect.

In the shops this sponge frequently goes by the name of the Venetian Bath-sponge, though in Europe the only name popularly employed seems to be that of Horse Sponge.

Sub-species **gossypina**.

The fibres are generally, but not invariably, somewhat coarser than those of *tubulifera*.

1. Primary fibres single, widely separated, continuous below, projecting above, stouter than those of *tubulifera*. The meshes of the connecting fibre are also very broad, sometimes extending without interruption from one primary fibre to another.

2. Primary fibres in groups, but not fasciculated. They converge towards the surface, and project in several apparently single points. Meshes of the connecting fibre narrow and long, or of equal dimensions, but never so large as in No. 1.

3. One section of sub-species *meandrina* shows the primary fibres absolutely free of debris, rising in single points above the surface, but not continuous; they being soon lost below the surface in the small, dense net work.

4. Another specimen of the same sub-species shows the primary fibres continuous below, coarse, loaded with debris, the connective tissue with a looser mesh and much finer fibres than No. 3.

Sub-species *cerebriformis* was found to have fibres of even a grade coarser than those of variety *typica* of *Spongia agaricina*, sub-species *dura*, and quite as dark colored.

1. In some cases excessively loaded with debris, which sometimes was not confined to the axes of the primary fibres, but hung in pieces from the exterior, apparently partly uncovered. Primary fibres are usually arranged in fascicles and bundles.

2. Primary fibres single, widely separated, connecting fibres placed nearly at right angles to these, but with a small mesh. The primary fibres always, and sometimes even the connecting fibres, loaded with debris. This last fact becomes of great importance in view of its exceeding rarity, and since it shows that under some circumstances even the generic characteristics of this part of the skeleton are subject to individual variation.

3. Same as above, but without debris in the connecting fibres.

4. Same as above; but the fibres are light colored, and in every essential point like those of *gossypina*.

5. Fibres of *obscura* closely resemble those of the coarser kinds of variety *gossypina*, but the connecting fibres are larger in proportion to the primaries.

Spongia gossypina Duch. et Mich., Naturk. Verhand. Holl. Maatsch. Wetensch., Haarlem, 1864, 21-2, p. 32, pl. 3, fig. 3.

The typical variety of this species, usually called the Wool sponge, varies greatly in form. All of these forms, however, are characterized by a peculiar surface. The skeleton rises into large tufts over the entire surface, the larger oscula occupying the depressions between. Sometimes these are very numerous, the whole interior being very cavernous, and sometimes the structure is much denser, with fewer large openings and many smaller ones scattered between the tufts. Occasionally, the depressions are filled up on parts of the sponge, and a surface is presented having no large tufts, but only the small secondary pointed bundles of fibres, which are especially characteristic of this variety.

The result of this structure is to leave great hollows, or rather a network of deep tunnels under the derm, which are apparent only after the drying of the specimens, when they become exposed by the universal contraction and cracking of the skin. The color when living is said by Dr. Palmer to be a shining black.

Loc., Biscayne Bay, Key West and Nassau, in Soc. Coll. Habitat, from three to sixteen feet, and deeper, the limits not being ascertained. The largest seen was about nine inches high by thirty inches broad.

Variety *dendritica*. This I have founded simply upon one form, Pl. xv, fig. 6, which is fistulose and branching, each branch having one large aperture at the tip. The surface is ornamented with the usual tufts of fibres and long ridges, as in *Spongia graminea*. There are others of similar texture in which the association is fistular, but the form is solid and not branching, though quite long.

Loc., Nassau, in Soc. Coll.

Variety *porosa*. These are also compound fistulose forms, but the tubes are widely scattered, short and wide-mouthed, giving the whole a flattened table-like aspect, and the skeleton between is very scantily built. One form of this variety has a denser skeleton

between the tubes, and the fistular aspect is consequently almost lost, Pl. XVI, fig. 5. This leads into the following form which may be styled normal or typical.

Loc., Nassau, in Soc. Coll.

Variety *alba*. The name alludes to the whiteness of the fibres. The preceding form merely increases in size with its widely separated fistular tubes (Pl. XV, fig 4), and with a dense skeleton between, rounding upon the top until quite a tall, stout head is built up, which in its most perfect form is quite symmetrical, but this leads into fistulose forms, such as the figure (Pl. XVI, fig. 7). The primary tufts are very large in this variety, as in variety *isolata*. With this I should also associate the large, flat-topped, large apertured and loose textured specimens, which have small bases of attachment and rounded swelling sides. There are also some very interesting forms which lead from these into the next. They have the same surface and texture, but instead of many, have only one large aperture in the centre of the elongated circular head.

Loc., Biscayne Bay, Nassau, in Soc. Coll.

Variety *solitaria*. This (Pl. XVI, fig. 3) has only one large aperture, with a very much elongated, and altogether fistulose, aspect. The difference consists in the absence of the fibrous tufts over considerable spaces, giving the surface thus changed a peculiarly solid aspect. This leads into sub-species *meandriniformis*.

Variety *hirsuta*.¹ This (Pl. XVI, fig. 4) is distinguished by the enormous length of the tufts, and the great number of the orifices and channels, rendering this variety exceedingly soft, and the surface particularly cavernous in appearance.

Loc., Nassau, in Soc. Coll.

Sub-species *meandriniformis*.

Spongia meandriniformis Duch. et Mich., Op. cit., p. 33.

This, the well known Velvet sponge of commerce (Pl. XVI, fig. 2), is undoubtedly the form described by Duchaissing and Michelotti. It differs from the preceding in its extreme forms by the absence of the pointed bundles or tufts, and the fibres also are perhaps slightly finer. The absence of the pointed tufts gives a smoother surface, since, as in the preceding variety, these are mainly composed of coarse primary fibres loaded with foreign matter, whereas the connecting or secondary fibres are composed of pure keratose. The surface is also remarkable for the protruding flattened cushions of fibre which slightly resemble the convoluted ridges of a *meandrina*. Sometimes these cushions are transformed into long, solid brushes, or pencils of fibre.

Loc., Biscayne Bay, Nassau and Key West, in Soc. Coll.; Island of Fernando Noronha, Havana, Mauritius, in Coll. Mus. Comp. Zoology.

Variety *barbara*.

Spongia cavernosa Duch. et Mich., Op. cit., p. 30.

“ *barbara* “ “ “ “ “ p. 31.

The irresolvable uncertainty which surrounds the identity of the actual form described under this name by Lamarek, has led me to think that its utter abandonment would be the best course to pursue. That any two independent workers should describe precisely the same form by this name seems to me improbable, in consideration of the fact that

¹*Spongia utilis* Duch. et Mich. I have not been able to identify this species or variety, but I think it may be the same as the variety “*hirsuta*” or “*porosa*” of *Spongia gossypina*.

no peculiarities are given by any one which could establish its identity. Esper's figure may possibly enable some one to settle this question, but I have seen no specimen which might be considered precisely identical. Dr. Ehler, in his recent review,¹ appears to have decided that Esper's original specimen belonged neither to the *Spongia cavernosa* of Duch. et Mich., or to the *Cacospongia cavernosa* Schm., and my own observations have led to the same conclusion.

It was with the greatest difficulty, also, that I could come to any conclusion with regard to the form described by Duchassaing and Michelloti. It may be well to remark, also, that the surface in this figure is even more wretchedly drawn than many of the others, and this greatly increased the labor of obtaining a satisfactory identification.

The principal characteristics of the form and surface ally this form so closely with sub-species *meandriniformis*, that I can only separate it as a distinct variety. The forms of the specimens (Pl. xv, fig. 5) in our collection are more spreading than is usual in that variety, and the texture is quite as soft, though denser, perhaps, when the skeleton is dry. The projecting cushions of fibre are similar in form to those of variety *meandriniformis*, but are joined together in larger masses by a tissue of fine superficial threads, which also are often less dense, and simply bridge the intermediate channels. This, and the tortuous and rather shallow character of the channels, gives the surface a smoother aspect than is common in the skeleton of *meandriniformis*. The oscules are very large, and have a peculiar ragged aspect in dried specimens. They look as if some one had made them by repeatedly running a knife into the animal while it was drying, and then omitted to clean out the interior thoroughly, leaving sharp pinnacles of dried sponge cuttings projecting inwards, sometimes so as to fill the centre, but oftener sticking out around the centre of the aperture, and more or less completely joined to the wall of the canal. This characteristic ragged look is sometimes also to be seen in the oscules of sub-species *gossypina*, but never so decidedly. The typical form is also known commercially as "Velvet Sponge."

Loc., Key West, Nassau, in Soc. Coll.

Sub-species *cerebriformis*.

Spongia cerebriformis Duch. et Mich., Op. cit., p. 32, pl. 3.

Variety *typica*. The aspect of this species, commonly known as one of the "Grass Sponges" is very similar to that of *Spongia agaricina*, sub-species *corlosia*, var. *typica*. The difference consists principally in the aspect of the surface. This is broken up by parallel longitudinal ridges of irregular length on the sides, each ornamented with one or two lines of tufts. These ridges extend on to the upper surface, giving them a markedly radiatory arrangement. The larger orifices are situated in rows in the channels between the ridges. The specimen figured (Pl. xv, fig. 7) is probably in every way identical with that figured in Duchassaing and Michellotti's work.

Variety *plana*. This variety (Pl. xv, fig. 8) seems at first to be identical with *complanata* and *circularis* of Duch. et Mich., but the figure given of *Spongia circularis* and the descriptions of both species, are not favorable to such an identification. The general form of the typical variety is very much compressed, being hardly ever more than three inches in depth, without much reference to the breadth; some specimens of this depth being eight or nine inches in diameter, while others are only two or three. Large specimens are very

¹ Die Esperschen Spongien. p. 6.

apt to have the interior pierced by galleries, which often honeycomb a sponge which seems superficially to be very solid. The top is covered by a remarkably thick membrane, which in many specimens is not pierced by excurrent apertures on or near the edges. This gives a partially smooth zone or border, which, when it is present, contrasts in a remarkable manner with the apertion of the central part. The whole of the top, with the exception of the border, is perforated by excurrent apertures of small size, so numerous that they are often separated only by the dividing wall common to the contiguous tubes. The sides may either be furrowed or have a pitted appearance, according to the presence or absence of tufts of fibres, but in no case are the furrows divided by such regular ridges as in variety *typica*.

Loc., Florida, in Soc. Coll., and Kingsmill's Islands, in Coll. Mus. Comp. Zool.

Variety *divisa*. The form is divided in this variety into several large flattened lobes, which are apt to have a rougher surface on the sides and be more cavernous than the colonies of the typical variety. The length of the tufts gives a furrowed aspect to the upper side of the skeleton in some specimens. According to Dr. Palmer's observations, the color of the animal while living is black, and it is found upon hard irregular bottom or corals in about two feet of water at low tide.

Loc., Key West, Biscayne Bay, in Soc. Coll., and Stono Inlet, S. C., in Coll. Mus. Comp. Zoology.

Variety *Mexicana*. This variety (Pl. xvi, fig. 28) approximates closely in form to variety *divisa*, but the loose open texture of the inner side, due to the number and close approximation of the excurrent orifices is replaced by a closer web, in which only few apertures are visible. It is in fact more like sub-species *corlosia* in this respect; the texture and surface, however, are like those of this sub-species.

Loc., Vera Cruz, in Mus. Comp. Zoology.

Variety *caliciformis*. The external surface (Pl. xv, fig. 9) of the dried specimen, and even the cavernous character of the interior, with the large openings of the galleries perforating the sides, are the same as in the preceding varieties. The differences are due to the form, which is regularly vase-shaped (Pl. xvi, fig. 30), and to the surface of the infundibuliform side. This last is not only perforated by numerous contiguous excurrent orifices, but also by many of the galleries from the cavernous interior. This gives to a portion of the upper surface a very much more rugged or broken up aspect than is found in the preceding varieties.

There are three skeletons of this form, two from Nassau, and one, locality unknown. The two from Nassau exhibit a light yellowish brown skeleton, nearly as harsh to the touch as that of *Spongia agaricina*, sub-species *dura*. One of the Nassau specimens has the inside of the cup of much denser structure than in the others, and the rim perforated. This transposition of the area occupied by the excurrent orifices is, however, not the only solecism. The surface of the sides is divided by deep channels into primary and secondary tufts, precisely similar to those of the following variety.

Variety *obscura*. This (Pl. xvi, fig. 29) is found at Nassau, and also occurs at Key West; at least the color of some skeletons indicate that locality, the fibres being harsh and deep brown to reddish brown near the centre. The surface is rounded, and pierced by numerous orifices surrounded by ridges and tufts of considerable length. The aspect of these is such that I formerly referred this form to variety *hirsuta* of sub-species *gossypina*. This variety also occurs at the Bermudas, according to Mr. Goode's collection. A collec-

tion of waste sent home by Mr. Saltonstall contained a number of this variety which conclusively settled the question of the affinity of the species; some of these specimens are forms of *gossypina*, and some of *cerebriformis*.

***Spongia agaricina* Pall.**

Spongia agaricina Pall. (Esper Pflanzth., 2, pl. 14).

Sub-species **Zimocca.**

Spongia Zimocca Schm., Op. cit., p. 23.

This species varies like *Spongia officinalis*, but the cup-shaped varieties are much flatter and broader, and from these there are all imaginable variations. The interior may rise into a prominent bulging dome-like centre, the excurrent orifices still presenting, however, the pitted aspect, and the surface the hirsute structure and dark color so characteristic of the species (Pl. XVI, fig. 22). These solid forms may be more or less lobed, and continue to grow until a very irregular lobate form is produced, which is almost a true branching stock. The qualities follow the same law of variation, the irregular forms being generally the coarsest, and these approximate in a remarkable way in quality and the aspect of the orifices and surface to the finer qualities of the American varieties.¹ The typical form, as figured by Esper, has all the peculiarities, including even the dark color of the skeleton, which is characteristic of this species; and since Dr. Ehler has referred it to this genus I do not think there can be any reasonable doubt as to the proper limitation of Esper's name.

Sub-species **dura.**

The fibres of all the American forms are considerably coarser than those of *gossypina* in all of the normal forms, but of course in some varieties this distinction does not hold.

1. The primary and secondary, or connecting fibres are equal in size. The former are continuous below, and single. The latter have a precisely similar aspect, and run parallel with the primaries for considerable distances before bending laterally to anastomose with others and form the mesh of the connective tissue. They are, however, never loaded with debris, but the mesh is, in consequence of this peculiar structure, long and narrow, and mostly arranged vertically.

2. Primary and secondary fibres project in tufts above the surface, and are connected by a third system of short horizontal fibres, as in the *Stelospongas* group.

Variety *typica*. This sub-species, the form known in commerce as Hard-Head or Honeycomb reef sponge (Pl. XVI, figs. 24-25, and Pl. XV, fig. 6) is very closely allied to sub-species *gossypina* in some respects. The color is darker and the texture denser than in the latter, and yields only to considerable pressure between the fingers. The surface presents large tufts of fibres, and between them canals, resembling in this respect the surface of variety *meandriiformis* of sub-species *gossypina*, but differs in the minor tufts of fibres. These are more minute than in *gossypina*, and present a more hirsute or bristly aspect. The typical commercial forms are not to be found in the shallower waters, they being mostly gathered beyond the depth of sixteen feet. The color, as reported by Dr. Palmer, is black when living, with a brownish tinge. He also says that they are usually more isolated than *gossypina*, and not closely associated with other sponges, though growing upon the reefs. The largest observed was probably about six inches high by sixteen to twenty inches

¹ The specimen figured is one of the exceptions to this rule, since it has a skeleton of remarkably fine texture.

broad. Both this species and sub-species *gossypina* have a tendency to grow up into rotund forms, which are, however, smallest at the base, and sometimes quite contracted at this point, especially if the object or area to which they are attached is small enough to limit the growth of the diameter of the base. The varieties are many, though not of a remarkable character, and therefore not so well known to spongers as those of *gossypina*.

Loc., Biscayne Bay, Nassau, in Soc. Coll.

One very remarkable specimen exists in the Collection of the Academy of Natural Sciences of Philadelphia, about a foot high and a foot broad at the base. It is a huge pile, so to speak, of the single fistular forms, like a bee hive. The depressions between the cone-like orifices are very deep and irregularly arranged in lines from the base to the summit. The surface is, however, the most interesting part. The primary fibres project in bundles of small size, very evenly distributed over the entire surface. They are both larger and longer than the similar bundles in the adult forms, and resemble closely those of sub-species *cerebriformis*. It required a close examination of many specimens in order to show any essential differences of surface, though the adults of these two forms are very distinct in this respect.

Loc., Bahama Islands.

It is not possible to distinguish some of the varieties of the Hard Head from those of the Yellow sponge. The irregular forms and looser textured varieties approximate to those of the sub-species *corlosia*, both in structure and aspect, and this is the case also with the young of many varieties in both series.

Sub-species *punctata*.

In this sub-species (Pl. XVI, fig. 23), the typical specimens have often a close resemblance to sub-species *tubulifera* in form; and the almost total absence of the larger primary bundles with their interstitial channels, increases this resemblance; the apertures are also frequently deeply indented on the outer side, as in that species. This form, however, is denser than any other, and the bristly minor bundles are in greater profusion and of greater length than in other varieties. The apertures also are more numerous than in the preceding variety, and about three-eighths of an inch in diameter. They open also superficially, instead of being buried in the channels between the large projecting cushions of the skeleton.

Loc., Nassau, in Soc. Coll.

Variety *densa*. In this variety (Pl. XVI, fig. 27) all shades of difference and transition are represented, until we come upon a form which is identical with sub-species *corlosia*. This can, however, like other varieties, be distinguished from that species by the number and small size of the apertures, their scattered distribution over the whole surface, and the toughness and darker color of the skeleton. The minor or superficial bundles of bristle-like fibres are hardly seen at all on the upper side of some specimens, and in all they are much less marked than in the preceding variety. This gives the upper surface a particularly smooth or even aspect, which is, however, broken up by numerous superficial anastomosing canals, which become more or less parallel upon the sides.

Loc., Nassau, in Soc. Coll.

In all of these varieties the forms may vary greatly. In the first they seem quite constantly club-shaped, or at least round clumps taller than they are broad, and narrower

at the bottom than near the top, which is rounded; in the second the same form is the typical one, but there are also some very flat table-like specimens; in the third the same forms occur with others, which manifest a tendency to throw out branches. In one or two specimens also from Nassau, which may be referred to this variety, the surface is precisely similar to that of *discus* or *tubulifera* in general appearance, but a close examination shows the numerous and peculiar tufts of primary fibres which distinguish this species.

Sub-species *corlosia*.

Spongia corlosia Duch. et. Mich., Op. cit., p. 31.

This, which is popularly known as the "Yellow Sponge" of commerce, was at first confounded by me with *Spongia dura*, the "Hard Head" (Pl. xvi, fig. 24), but an examination of a full series of forms showed that very considerable differences exist in the texture, though superficially there is little or no distinction in the aspect of the surface. Dealers can identify these varieties instantly by the color, which is usually lighter than that of the "Hard Head," and by the touch, the "Yellow Sponge" yielding much more readily and feeling less harshly under the fingers. These characters, however, only apply to the normal head-like forms and some of the varieties; many forms cannot be placed in either one or the other of the two groups with any certainty.

Loc., Nassau, in Soc. Coll.

Variety *gossypiniformis*. This is the most remarkable variety (Pl. xvi, fig. 26), and it approximates to *corlosia*, not only in external aspect, but in form and color and general texture. The form is similar to the fistular varieties, with one or two very large orifices above, and the color of skeleton is much lighter than that of the other varieties. It is also permeated by larger canals than in other varieties, and thus the general texture approximates more closely to the softer and more porous character of this sub-species.

Loc., Nassau, in Soc. Coll.

Variety *fusca*. The young, and some few older specimens which I have referred to this form from Key West, have the surface of the skeleton on the sides more like those of sub-species *dura* (Pl. xv, fig. 11; Pl. xvi, fig. 31). The skeleton of many of the young also presents characteristics almost identical with those attributed by Duchassaing and Michelotti to sub-species *cerebriformis*. The top surfaces are, however, not so similar; they being almost devoid of the broken aspect so characteristic of sub-species *cerebriformis*. The shape is pretty generally like that of an inverted, truncated cone; the top flaring more or less in all specimens, and either slightly gibbous, or flat. The excurrent orifices which occupy this area are but slightly protuberant, and there is no such marked zone between them and the sides as in sub-species *cerebriformis*, variety *complanata*, nor are the apertures, even when small, so numerous, or arranged according to any describable plan. The color in a living state is black, and the largest specimen observed by Dr. Palmer was about eight inches in height. This collector also reports it as found growing almost exclusively upon coral and other sponges. One young specimen has a projecting branch in every respect identical with the following.

Variety *elongata*. This (Pl. xv, fig. 10) has an elongated form, sometimes slightly branched, the branches thick and club-shaped, but never fistulose. The larger number of the specimens are young, and were collected from Biscayne Bay, and named by Dr. Palmer "Small Hard-Heads." This commercial designation is, however, of doubtful correctness.

There is, it is true, considerable resemblance to sub-species *dura*, the true "Hard-Head," but there are also some differences. The surface and structure of the skeleton and fibre are quite distinct. When living the surface probably closely resembles that of *fusca* and *dura*, since we find here, as in those forms, groups of the round, small, incurrent openings.

The smoother aspect of the surface where it is covered by the dried skin, distinguishes this variety at once, but the surface of the skeleton is (Pl. xvii, fig. 1) broken up by the ridges into hexagonal or angulated cells of small size, which contrast forcibly with the more irregular and broken surfaces of other varieties. This is due to the closer approximation of the primary tufts and ridges which support the membrane.

Loc., Biscayne Bay, Key West. Habitat, reef, two feet of water at low tide, and deeper.

Spongia vermiculata Duch. et Mich.

Spongia vermiculata? Duch. et Mich., Op. cit., p. 35.

Spongia lacinulosa Duch. et Mich., Op. cit., p. 35, pl. 4, fig. 4.

1. The primary fibres are very coarse, numerous, closely set, but not continuous below. They project, however, in tufts above the surface, and are united by numerous short connecting fibres.

2. In several instances in varieties *papyracea*, *negligens* and *mollicula*, the primary fibres are continuous below.

3. The mesh of the connecting fibre is exceedingly small and irregular, giving the sponge extraordinary density and hardness. The primary fibres are continuous, coarse, and loaded with debris, and run across the mesh of the connecting tissue like small ropes laid on thread lace.

4. Primary fibres in the same sponge sometimes form fascicles or tufts like those described above, and are sometimes single.

Variety *lacinulosiformis*. Why Duchassaing and Michelotti should have selected this particular species as the *lacinulosa* of Lamarek, is not plain to me, since Pl. 16 of Esper only illustrates a very common variation of the surface in *Spongia officinalis*, and an aspect of this part which might be anticipated in any species. According to Lamarek's first edition, he regards the whole of *Spongia officinalis* Esper as equivalent to his *Spongia lacinulosa*, and particularly designates the same localities, the Red Sea and the Indian Ocean.

The oscules are numerous, and their prominence gives the whole mass a sub-fistulose aspect. The tufts are developed in the greatest abundance, and are often themselves more or less dendritic. The whole aspect of the skeleton is distinct from that of *Spongia lignea*; it is not so dense, and the fibres are coarser and darker colored, resembling somewhat in their appearance those of the finer species of Spongelia.

Loc., Coast of Florida, in Yale Coll.; Teneriffe, in Soc. Coll.

Variety *vermiculatiformis*. This form differs from the preceding variety chiefly in the texture, which is more open, though as stiff to the touch. The fibres themselves are very stiff, as in some specimens of the preceding variety. The surface is apt to be smoother, as in variety *levis* of *Spongia lignea*, and the whole aspect of the mass lighter, very irregular in form, and with oscules not noticeably elevated in the dried skeletons.

I have called it *vermiculatiformis* from its resemblance to the description of *vermiculata* by Duchassaing and Michelotti, with which it may be identical.

Loc., near Ft. Pierce, mouth of Indian River. Found dried on the beach.

Variety *negligens*. The Key West specimen (Pl. xvii, fig. 4) of this variety is so cavernous that it resembles an irregular roll or bundle of anastomosing branches. The surface is smooth, but the skeletal structure is very similar to that of variety "*vermiculatiformis*."

The Nassau specimens (Pl. xvii, fig. 2) are more solid, and exhibit large oscules which are absent in the preceding. They are also very cavernous, but the epidermis of the mass when living evidently covered all the internal inequalities caused by the channels. This variety may possibly, and in fact the whole species may be in part the *Caccospongia mollior* Schmidt.

Variety *papyracea*. A specimen labelled "East Indies," from the Collection of Yale Museum, has a dendritic form, but otherwise, in texture of skeleton and general aspect of the fibres and their arrangement, it resembles variety "*negligens*."

Sub-species *mollicula*.

There are very interesting specimens of this form from Zanzibar, Coll. Peabody Academy of Science, and Aspinwall, Yale Coll. The fibre is of the softest and finest description. The mass is also much denser than in variety *negligens*, and the texture excessively irregular. It is quite possible that this variety may turn out to be a distinct species. The surface is very similar to the smoothest and densest varieties of sub-species *tubulifera*. The interior is not at all cavernous, and the surface is very irregularly seamed by crooked channels and pitted with oscula of small size.

Sub-species *Cookii*.

Specimens of the typical variety of *Cookii* have the surface covered by coarse tufts, and in the same specimens the fibres differ greatly in size, being in some parts very coarse and in others very fine. The color also varies from light yellowish brown to dark red. The dried skeleton is harsh, but elastic and not easily broken by pressure, though very readily torn apart, differing in this respect very much from the typical Spongiae.

Loc., Zanzibar, in Coll. Peabody Academy, and Soc. Coll. Collected by Mr. Caleb Cook, of Salem.

Variety *ditelliformis*. The general texture appears to resemble that of *Cookii*. The number and arrangement of the canals, their irregularity, and the complete manner in which the interior was honeycombed by them, together with the veil, are, however characteristic, altogether distinct. There is also a complete absence in all parts of any primary fibres properly so called, the whole texture being typically Spongian. The veil is composed of the internal fibres, which are deflected and closely interwoven in the same plane, bridging over larger internal openings and canals, and reducing the apertures to a very small size. This specimen shows that the Ditelian veil may in its most complete form be possessed by true Spongia as well as by Spongelia and other genera.

Loc., Island of Fernando Noronha, in Coll. Mus. Comp. Zool.

Variety *tectoria*. This variety is dendritic in the two specimens which were examined. The internal texture was similar in every respect to that of the preceding variety, but the veil was the marked characteristic. It extends over the whole surface, and the mesh is circular or cellular, very much smaller than in the interior, and composed of much finer threads, here and there underlaid by the coarser fibres of the interior.

Loc., Pacific, U. S. Ex. Exp., in Yale Coll., and Coll. Mus. Comp. Zool.

Another specimen, in all probability belonging to this form, in the Yale Collection, has a precisely similar mesh but no veil. The mesh is small and remarkably regular, and there are no well marked primary fibres. No locality.

***Spongia lapidescens* Duch. et Mich.**

Spongia lapidescens Duch. et Mich., Verhand. Maatsch. Wetensch. Haarlem, 1864, 21-2, p. 34. Spong. de la Mer Caraibe.

This species is very closely allied to the typical variety of *Spongia vermiculata* in the aspect of the surface, and general texture and hardness of the skeleton; this is especially the case with the fistulose varieties. The whole aspect of the surface, the tufts and their structure, show considerable affinity with sub-species *cerebriformis*, but on the other hand, the extreme density of the skeleton and stiffness of the fibres seems to indicate that a separation is necessary. The permeability of the outer membrane to debris of all kinds also favors this conclusion.

Variety *typica*. The entire surface (Pl. xvii, fig. 3) is covered by tufts of fibres, which are parallel and closely appressed, but rarely connected by lines of secondary fibre. These bundles in some specimens may be very thick and brush-like. They approximate to the aspect of the surface in sub-species *Mauritiana*, which has similar large bundles of fibres, but of a more complicated or net-like structure similar to the body of the skeleton. The peculiar structure of these tufts is shown by the chenille-like aspect of the tops, due to the projecting free ends of the primary fibres.

Loc., Havana, in Coll. Mus. Comp. Zoology; Florida, in Soc. Coll., and Hayti, in Coll. Peabody Academy, Salem.

Some specimens of this variety have tufts of all shapes and sizes, and one is nearly smooth on one part of the surface, showing very prominently the small round oscules peppered in between the tufts. This leads into the next variety.

Loc., Havana, in Coll. Mus. Comp. Zoology, and Soc. Coll.

Variety *tetheiformis*. The name alludes to the faint resemblance to a dried *Tethea*, due to the similar aspect of the tufts of parallel fibres and the bundles of threads in a dried specimen of that genus. These are very long and very closely set, often joined into crests, parallel and quite sharp above, differing in this respect from the blunt aspect of the bundles on the cracked surface of a dried specimen of the siliceous genus *Tethea*.

Loc., Havana, in Society's Coll., and in Mus. Comp. Zoology.

Variety *intermedia*. The texture is generally somewhat looser, the oscules larger and the tufts longer and more irregular, varying in the same specimen from forms comparable with those of the typical variety to those in which they assume a fan-like outline, and are composed of only a thin layer of fibres.

Variety *turrata*. In this variety (Pl. xv, fig. 12) the parallelism of the fibres of the superficial bundles is less noticeable than in the preceding variety, these parts being, as in the generality of the *Spongiæ*, composed of fibres more or less interwoven. The fan-shaped or flattened tufts, however, usually have the fibres parallel, and the surface is similar to that of the other varieties, with the following exception. Large oscules occur irregularly scattered over the mass, which are elevated upon fistular projections of the skeleton. Near the apertures the walls of these are remarkably thin, and built up of the same tissue as the body of the sponge, but with a more regularly elongated mesh and more decided

development of primary fibres. I am informed also by Mr. Goode, that this sponge is apparently very abundant, and is the principal useful sponge found in the lagoons of Bermuda. It is, however, too coarse for anything but the roughest purposes.

Loc., Bermuda, in Coll. Wesleyan University, Middletown, Mass., and Soc. Coll.

Sub-species *dentata*.

This form (Pl. xvii, figs. 6, 7) is represented by only one specimen, one of the most remarkable species I have yet seen. The whole surface is covered by a hard, even crust, similar to the tough epidermis of *Geodia*, and resembling it in color. It extends over the whole external surface, both above and below, but is not found in the endoderm lining the canal system. Microscopical examination disclosed the curious fact that it was probably due to the great extent with which the epidermis of the animal while living was loaded with fine calcareous mud. The whole figure, which is of an irregular outline about 300 mm. in diameter, is only about 40 mm. in the thickest part, and is covered above as in variety *typica*, by the usual tufts. These, however, are very regular in distribution, of small size, round, and quite pointed. There are also larger oscules sparsely scattered over the surface with crater-like walls of about 5 mm. in height. The figured specimens are parts of a fragment of a large colony in the Collection of the Museum of Comp. Zoology.

Loc., Havana, in Mus. Comp. Zool. and Soc. Coll.

Sub-species *Mauritiana* Hyatt.

This variety (Pl. xvii, fig. 5) is remarkably cut up by internal channels which permeate the substance in every direction. These are quite large, elliptical in outline, and about a quarter of an inch in diameter, and give the sponge a very rough aspect on the surface, which in perfect specimens rises into prominent tufts and ridges between them. The fibres are remarkably inelastic, and the whole mass unyielding to the touch, but not brittle, friable, or easily broken.

Loc., Mauritius, in Coll. Mus. Comp. Zool. and Soc. Coll.

Variety *Pacifica*. This is an incrusting form, permeated by similar large channels which, on account of the thinness of the mass, give the sponge a perforated aspect when held up to the light. The surface is very rough, and is cut up by parallel ridges and irregular shaped elevations, bearing either rows or bunches of projecting fibres.

Loc., Pacific Ocean, U. S. Ex. Exp., Yale Coll. and Society Coll.

Variety *decidua*. This variety, although precisely similar in structure to the variety last described, differs slightly in the aspect of the surface. The projecting ridges are transformed into bunches, sometimes solid and sometimes fringed by the projecting free ends of primary fibres. There is a tendency also in parts to extend these into a sort of velum covering over the intermediate spaces. This is particularly the case upon the lower side of the specimens from Mauritius, and a part of the upper surface in the Havana specimen.

Both specimens are in the Coll. Mus. of Comp. Zool.

Stelospongos Schmidt.

This interesting group, described by Schmidt, is readily distinguished in most species by the compound structure of the primary fibres, but in others the primary fibres are not so closely associated. The primary fibres are associated in bundles, and closely connected by secondary fibres. Sometimes these primary fibres are nearly parallel, sometimes branching

at intervals into a succession of fan-shaped figures. These appear upon the surface of the species which possess this mode of growth as flat, fan-shaped, or fascicular bundles, with a narrow mesh formed by the thickly set and horizontal secondary fibre. In some species the bundles, growing broader towards the surface, would thus become of enormous size if there was not a secondary system of branching which separates the large ones into two or three smaller bundles. There are none of these, properly speaking, in some other species, but only closely connected sheets of parallel primary fibres with the usual close net work formed by the approximation of the horizontal secondary fibres; these lead into the genus *Spongelia*, between which and this genus no definite and constant differences, applicable to all the species without reservation, have been found in the skeleton.

In all the species I have yet seen, the general system of connecting tissue formed between the bundles by the secondary fibres has a remarkably loose and open texture. Of course there would naturally be a great variation in such a characteristic, but as compared with either *Spongelia* or *Spongia*, this portion of the skeleton is very loosely put together, and the mesh is usually either of a very irregular form, or composed of horizontal secondary fibres united by an independent series of shorter vertical fibres. The bundles of primary fibres radiate from the interior outwardly, and with the connecting tissue of secondary fibres form a mass of more or less perfect tubes also radiating outwardly, as in *Spongelia*; and at intervals horizontal canals are formed which connect these tubes with each other, and are of about the same diameter.

***Stelospongos Maynardii* Hyatt.**

The typical specimen (Pl. xvii, fig. 21) of this species is fistulose, but with very thick walls below; the greatest diameter is about 110 mm., height about 150 mm. The central canal is largest at the opening, which is about three-quarters of an inch in diameter, and the walls are composed of enormous bundles of primary fibres, which sometimes attain a thickness of 7 mm., though generally not more than half that in diameter. The bundles are irregularly rounded fascies of primary fibres, bound together by short, thick, secondary fibres, so closely arranged in parts that the intermediate spaces appear like the rounded holes in a sieve, or cullender, while in other parts of the same bundle they may be so wide apart that they resemble more nearly the square spaces between the rounds of a ladder. The primary fibres are always very thick, closely set, and often branch at intervals. This latter characteristic causes a constant increase in the thickness of the bundle, and these would soon attain an unwieldy size if they did not, as they grow outwards, again divide at intervals into two or three diverging fascies. All of these are bound together by a net work of secondary fibres, much coarser than those connecting the primary fibres inside of the bundles, and the mesh is exceedingly large and loosely looped up between them. This connecting system and the bundles of fibres together, form the wall of an unusually regular system of tubes leading into the central fistular cavity. The external openings of these are thickly set, and may vary from 7 mm. in diameter to half that size. The surface of the skeleton is excessively rough, on account of the great size of the fibres and bundles, the number and size of the orifices and the loose arrangement of the connecting fibres. Perhaps this is even more to be attributed to the irregularity caused by a system of very deep channels connecting all the smaller orifices. These break up the surface and give the bundles the aspect of standing out very prominently from the surface,

whereas, in all the spaces between the orifices and this system of channels the connecting secondary fibres are almost even with the tops of the bundles of primary fibres.

Loc., Key West., in Soc. Coll.

I have also received, by the kindness of Prof. J. W. P. Jenks, a specimen (Pl. xvii, fig. 22) of a distinct form, but which at present I prefer merely to mention in connection with the above. It differs from *S. Maynardii*, solely in the smaller size of the bundles of primary fibres, their close approximation, and the greater quantity and density and smaller mesh of the connecting skeletal tissue. The specimen has the fistular form, and the locality is unknown.

Stelospongos levis Hyatt.

The forms (Pl. xv, fig. 16) of the two specimens examined were rounded and fistular, the height being about 108 mm., and the greatest diameter 70 mm. The whole base of *S. Maynardii* rested upon the rock, whereas this specimen has a thick, short pedicle, and the walls of the fistular aperture are thin and fringe-like, instead of thick, as in *Maynardii*. In the skeletal structure there can be no close comparison, except in the generic characteristics. The radiating primary fibres form flattened, fan-like expansions, which are particularly noticeable on the surface. The reticulations are more generally open or ladder-like than in *Maynardii*, and the whole, as well as the connecting net of secondary fibre, much finer and denser than in that species; and the incurrent tubes more numerous and closely set, and less distinctly divided by the tissue of connecting secondary fibres. The apertures are not connected by any special channels, and the surface is therefore even, though roughened by the projecting fan-like tufts of primary fibres.

Loc., Pacific Ocean, U. S. Ex. Exp., in Yale Coll., and New South Wales, in Coll. Acad. Nat. Sciences, Philadelphia.

Variety *rotundus*. The two specimens (Pl. xvii, figs. 23-24) examined were erect upon short, thick, peduncular bases. One, however, has a gibbous fistular form, though the central aperture is quite small, and is accompanied by several smaller ones running in a line across the summit. The other is broader near the top than at any other part, and has several excurrent orifices irregularly placed, partly on the top and partly on one side. The structure is denser than in typical *levis*, owing to the close proximity of the bundles of primary fibres. These have, however, the same structure, branching at intervals into fan-like expansions of lattice work, resembling those used by florists for vines and flowers; they project considerably, and are so closely set that the whole surface has a characteristically shaggy aspect. The tissue of connecting secondary fibres is almost as unimportant and as open as in *Maynardii*.

Loc., Phillip's Island, off Port Phillip's Head, Australia, in Soc. Coll.

Stelospongos friabilis Hyatt.

In the single specimen examined, the principal difference lies in the slight distinction between the tissue of the primary fibres and those of the secondary. Both are much finer than in any of the preceding, and present a vesicular aspect. They are also so mingled together in parts of the specimen that the observer fails to distinguish between the primary fibres and the connecting tissue of secondary fibres. The bundles of primary fibres become apparently simple lines or columns formed by a denser aggregation of the connecting tissue. In other parts of the same column or bundle the primary fibres can be singled

out, principally, however, owing to the fact, that they are more or less charged with introduced material. The bundles project above the surface, and are arranged along the sides or as divisions between the channels which connect the mouths of the numerous tubes, which penetrate to the surface without any special order of arrangement. The bundles are smaller than in any of the preceding species, and, in fact, are really in some parts only single fibres, as in *Spongelia*. This minuteness, their stiffness and projecting character, make the surface look as if it were set with bristles.

Loc., Zanzibar, in Coll. Peabody Academy, and in Soc. Coll.

***Stelospongos cribriformis* Hyatt.**

The surface of the skeleton presents precisely the aspect of *Spongelia*. This is owing to the regularity with which the bundles of fibres occur upon the surface, and their small size, as well as to the regularity with which these are connected by ridges of associated secondary fibres; which also, on account of their minute size, resemble the single secondary fibres of *Spongelia*. The linear or radiatory arrangement of the associated primary fibres forms long and more or less continuous tubes penetrating into the interior; these are so perforated or pierced by connecting holes through the skeletal walls, that they appear very irregular. These holes are nearly, or quite, equal in diameter to the tubes, and entirely interrupt the primary fibres. The division walls between these holes are formed by large secondary fibres stretching across from one set of primary fibres to the next. These are again connected by a third set of fibres which run from one horizontal secondary fibre to the next. Sometimes this regularity is not apparent, and only an irregular network is visible, in which no distinction can be made between the horizontal and connecting or tertiary set of fibres. In some parts of the same sponge, also, all regularity is lost, and the whole is a network of irregular size and shape, similar to that of the true *Spongiæ*. This is especially the case with the following.

Variety *stabilis*. In this variety (Pl. xv, fig. 15; Pl. xvii, fig. 25) the tissue is unusually dense, and the surface is not marked, except in spots, by the usual tissue of cellular aspect, due to the opening of closely contiguous tubes upon the surface of the skeleton. The primary fibres are also indistinct in the interior, and a considerable part of the skeleton has the irregular mesh just described. The primary fibres are shown only upon one side of the surface, and here, also, tubes are found.

Loc., Key West, in Yale Coll., Havana, in Coll. Mus. Comp. Zool.

A Havana specimen combines the structure of the former with that of the next variety, having a similar surface but more decidedly tubular, a hollow interior and an intermediate size to the mesh of the skeleton. There is also a specimen from Nassau in the Society's collection having something of this intermediate character, though perhaps, strictly speaking, it ought to be included in the next variety.

Variety *typica*. The surface of this sponge, Pl. xv, fig. 14, is more perfectly cellular or coral-like than that of any sponge I have ever seen. The vertical walls between the tubes are formed of very dense tissue, and there are but few horizontal threads crossing the mouths of the tubes; in fact, in some parts of each colony none at all. The mouths of the tubes vary greatly in diameter, but in some specimens reach the diameter of 5 mm. The intimate structure of the skeleton is distinct from the Key West specimen of variety *stabilis*, but is only a less variable form of that found in the others of the same variety.

The walls of the tubes are made up of vertical fibres not very wide apart, and connected by closely approximated secondary fibres. The primary fibres are gathered into groups of two or more, standing in the same plane, though occasionally, at the corners of the tubes, solid groups are formed by the branching of the fibres; then either new tubes arise between the branches, or solid fascies are formed, as in *Stelospongos Maynardii*. The form, instead of being solid and crest-like, as in variety *stabilis* (Key West specimen), is like that of the Havana representative of that variety.

Loc., Havana and Hayti, in Mus. Comp. Zool., and in Soc. Coll.

Stelospongos Pikei Hyatt.

The skeleton of this species is represented by many beach-worn specimens collected at Mauritius by the English Consul, Col. N. Pike, [Coll. Mus. Comp. Zoology and Soc. Coll.]. They are highly colored, of a yellowish brown hue, and very hard and inelastic. The surface presents the aspect of *Spongelia*. The fibres are apparently single, and project in the form of stiff bristles, about 5 mm. long, where they have not been worn off by friction on the beach (Pl. xvii, fig. 20). The tissue between is dense, and is penetrated by apertures of variable size, irregularly scattered over the surface. Upon closer examination, it becomes apparent that most of the fibres are not single, but really compound bundles. The fibres composing these may be so closely joined in the interior that it requires critical examination to detect their compound character, or they may be quite wide apart. The connecting tissue of secondary fibre has a very close and dense, but irregular mesh, resembling in this respect the connective tissue of *Verongia fistularis*. In some parts of some specimens a very remarkable and characteristic variation was observed, similar to the Diteliform variation of the surface previously described. A web of very fine white fibres crosses the larger meshes, and connects the dark yellow, horn colored fibres of the original skeleton. This is so fine and so dense that it has a downy or fleecy look on the cut surface of a section.

Stelospongos intertextus Hyatt.

This species is represented by only one specimen, in the Collection of the Museum of Comparative Zoology, from the Mauritius. It resembles *Spongelia enormis* in form, but has only a few scattered excurrent orifices on the dried skeleton. The texture is remarkably light, and very closely resembles that of *Spongelia*. Upon close examination, however, it can be seen that the primary fibres branch frequently; that these branches run parallel for a considerable distance and are loosely united by short secondary fibres. The general connecting tissue of secondary fibres resembles the irregular texture of some species of *Spongelia* in which no very distinct tubes are formed. The arrangement of the primary fibres on the surface, at first led me to suppose that this might be the young of some variety of *Spongelia enormis*. If the primary fibres were single, I should not feel justified in separating it; but I have not, however, so far found that the compound character of the fibre is a characteristic of the young of either *Spongelia* or *Spongia*; and, therefore, until we know more of the animal, it seems to me safest to classify the debateable species according to the character of their primary fibres. Thus, though this is a true *Spongelia* in general aspect, lightness and elasticity of texture and form of the mesh of the general tissue of secondary fibres, I prefer to consider it a member of the genus *Stelospongos* on account of the characteristics of the primary fibres.

SPONGELIA Ndo.

Dysidea (pars) Johnson.*Spongionella* Bow.*Caccospongia* (pars) Schmidt.

This genus is readily distinguished from *Spongia* in the dried specimens of most of the species by the character of the surface. It is made up of contiguous, sunken, angulated areas, giving the surface a cellular aspect, like that of a cut honeycomb. The cells are not deep, and are formed solely by the shrinkage of the outer membrane over the projecting points of the primary fibres. These are large, radiatory and single; the connecting tissue of secondary fibres is also characteristically regular in most species, and has a large, loose mesh, with the fibres at right angles with the primary fibres. The surface is covered by the projecting primary fibres, and as these are single they give a fine woolly aspect to the otherwise even surface of the skeleton, quite distinct from that of some species of *Spongia*, or of any other genus. The secondary fibres are clear, and the primary fibres usually, though not in all cases, loaded with foreign matter. Quite a number of the species show exceptional characteristics, but all of them appear to have the characteristic singleness of the primary fibres. Several species show the peculiar modification described by Schmidt as a distinct genus, *Ditelia*. In one species, *Spongelia velata*, the surface is so completely changed in this respect that I am not entirely convinced that it may not some day justify a new generic group. There is no doubt, however, that what was described first as *Ditelia* was only a common variation liable to occur in any species of either *Spongia* or *Spongelia*, as was subsequently shown by Schmidt himself.¹ The figure of *Spongionella pulchella* Bow., appears to show that this species is a true Spongelian, and the microscopical figure of the fibres and the written description, are very characteristic of *Spongelia*.

***Spongelia incerta* Hyatt.**

I presume that no one would suspect this specimen (Pl. XVI, fig. 32) of being anything but a pedicellated form of the true genus *Spongia*. The surface is smoother even than in *Spongelia densa*, the mesh of the fibres very small, and the fibres themselves, like the finest of the *Spongiæ*, are very elastic and closely woven. I did not suspect the real affinities of this interesting form until a section was made, when the comparatively large primary fibres loaded with foreign matter, and the character of the connecting tissue, became visible. The spaces are filled by the finest fibres forming a close cellular network, much more regular in the form of the mesh than is common among the true *Spongiæ*. In some parts where the primary fibres approximate, the secondary fibres here and there stretch across, forming the usual ladder-like tissue. The form is flabellate, but very thick in proportion in the centre, so that when seen from above one side is very gibbous. The pedicle is long and rather small, but with the usual dense hard texture of the pedicellated forms of *Spongelia*. The excurrent orifices are scattered, but the majority occupy the outer edge. The incurrent orifices are very numerous, regularly distributed over the entire surface, and can be plainly seen in the skeleton as round holes. The surface is otherwise perfectly smooth.

Loc., Phillips Island, Australia, in Soc. Coll.

¹ *Spongiën* d. Adriat. Meeres, 1862, and Suppl., 1864.

Spongelia velata Hyatt.

This extraordinary sponge (Pl. xvii, fig. 8) appears at first sight to have very good claims indeed to the distinction of occupying a group by itself. The surface is composed of a veil of finer texture than the interior, which, as in *Spongelia cana*, variety *cineta*, limits the number and diminishes the size of the excurrent orifices. This veil, however, is much more distinct from the body of the skeletal fibres than in any other species in which such a modification of the surface has been observed, and may possibly be quite general and of specific value. This is doubtful, however, and at present it is best to look upon it as the exaggerated development of a variation, probably due to the habitat of the sponge. It is, however, in these specimens, a thin epidermal covering, while in all other cases it is merely a denser aggregation of the secondary fibres as they approximate to the surface. In *Spongia Mauritanica*, variety *tectoria*, a very similar thin covering spreads over the whole surface, but even this is not distinctly separated from the internal fibres, but seems rather a network of minute fibres stretching across the open meshes of the larger fibres, which also form a portion of the veil texture. In this species, however, the internal fibres do not interrupt the smaller fibres, which form the entire substance of the veil on the outer side. The fibres are coarse, the mesh very irregular in shape and size. The arrangement of the primary fibres seems to be in thick sheets, or fan-shaped expansions, which radiate outwards.

It will be seen that it is really similar to the structure of *Spongelia dubia*, variety *excavata*, but with larger and more irregularly shaped canals and less solidity to the skeletal partitions between them. No comparison can be made, however, between the intimate structure of the skeleton itself, this species being in every way so much coarser fibred and more irregular, the color also inclining to dark red or yellow.

Loc., Zanzibar, in Coll. Peabody Academy, and in Soc. Coll.

Spongelia dubia Hyatt.

This species (Pl. xvii, fig. 9) resembles in general aspect the figure of *Dysidea fragilis* Johnst., but the description of the latter seems to show that Johnston really described a true *Dysidea*, and not a member of this genus at all. The specimens examined from Biscayne Bay of the typical variety, are remarkable for the smooth aspect of the surface, due to the closeness of the projecting points of the primary fibres, which hold up the epidermis and prevent it from settling down between them into the usual pit-like depressions on some parts of the dried specimens. On other parts of the surface the depressions are present, but much smaller than in any other species. The primary and secondary fibres are quite regular in their arrangement, and there is but a slight development of the irregular network, so characteristic of some other species. Habitat, shallow waters. Color when living black.

Loc., Biscayne Bay, in Soc. Coll.

Variety *mollior*. This variety, if it really does belong to this species, is described from a type specimen named by Schmidt *Caccospongia mollior?* Schm. The texture is fine, the primary fibres distinct, and the mesh of the tissue of secondary connecting fibres similar to that of the typical variety, but considerably finer. The primary fibres do not project perceptibly above the surrounding surface, which is quite smooth. The form is

tabulate and lobed, with numerous closely approximate excurrent orifices on the flattened upper sides of the lobes, and central part of the mass.

Loc., Florida, and Island of Noronha, Prov. Pernambuco, S. A., in Mus. Comp. Zoology.

Variety *excavata*. This (Pl. xvii, figs. 10-11) differs from variety *mollior* in having a slightly coarser texture with coarser primary fibres, but a similar smooth surface. The forms are rounded, and have numerous large, scattered, excurrent orifices. These lead into correspondingly large canals which intersect each other in the interior, and give the whole mass the appearance of being excavated or hollowed out. They are precisely similar to the Australian form, *Spongelia rectilinea*, but have a skeleton of finer texture, with less prominent and more numerous primary fibres.

Loc., Florida, in Mus. Comp. Zoology and in Soc. Coll., and La Paz, Lower California, in Soc. Coll.

Variety *foraminosa* Hyatt. The form and the surface of this variety are altogether peculiar. The sponge is, in reality, made up of an aggregation of large tubes radiating towards the circumference, and divided by tolerably thick walls. The regularity of the arrangement of these tubes and their increase in size outwardly, is the marked characteristic. The texture is of medium fineness, with nearly parallel, and quite closely set primary fibres in a specimen from Havana, in Coll. Mus. Comp. Zoology, in another, however, from Ft. Macon, in Yale Collection, the primary fibres are more widely separated, and the tissue is altogether looser. The secondary system of canals is also very well developed, and the interior therefore resembles that of the preceding varieties, though not so completely hollowed out.

***Spongelia cana* Hyatt.**

This species has a remarkably white skeleton, although two of the three specimens examined evidently were not entirely free from animal matter; the exteriors are bleached very white. The general plan of the mass is similar to that of *Spongia Mauritiana*. Its resemblance to this last, in fact, is complete in form, aspect of the surface, and in the labyrinthine windings of the canals. The primary fibres are regularly distributed, and the secondary fibres connect them in a perfectly normal manner; the size of the fibres and the whole texture is as fine as that of any Spongelian yet observed.

Variety *cincta*. This is precisely similar in every respect, except that the whole exterior is covered by a thick layer of somewhat denser texture than the internal skeleton. This gives the surface a remarkably smooth aspect, covering up all the marked inequalities, and decreasing the size and number of excurrent orifices. The tissue of both varieties is similar to, but considerably finer than, that of *Spongelia excavata*, which they resemble more closely than any other species.

Loc., Noronha, Prov. Pernambuco, S. A., in Coll. Mus. Comp. Zoology.

***Spongelia spinosa* Hyatt.**

The exterior of this species (Pl. xvi, fig. 33) is peculiarly rough or spinous, owing to the projecting points of the primary fibres, which extend considerably beyond the surface. The connecting tissue consists of a very irregular network of fibres. It is pierced by excurrent orifices, and occasionally marked by a channel. This tissue resembles that of *Spongelia incerta*. The absence of vertical tubes is also another similar characteristic;

the differences lie in the presence of continuous lines of primary fibres and the lesser density of the whole skeleton.

Loc., Mauritius, in Mus. Comp. Zoology, and in Soc. Coll.

Variety *rigida* Hyatt. This, after much hesitation, seems to be appropriately classified only when considered a distinct variety. The surface of the skeleton is covered by a thick growth of primary fibres. The general texture is finer than in *Spongelia dubia*, which it resembles closely, and the fibres smaller. It also still more closely resembles the typical variety of *spinosa*, but even here the texture is not exactly similar. The primary fibres are perfectly regular, and join the secondary fibres at right angles, and the projecting parts of the primary are never surrounded by any deflected secondary fibres, as in variety *spinosa*.

Loc., Beach at Ft. Pierce, Indian River, Fla., in Soc. Coll.

Variety *Codmani*. This variety was gathered by Mr. Codman at the Island of Teneriffe, and differs from the preceding only in the lightness of the skeleton, the smaller size of the fibres, and the irregularity of the form. The surface is also a trifle less spinous.

***Spongelia Farlovii* Hyatt.¹**

Variety *densa* Hyatt. One specimen (Pl. xvii, fig. 14) has a flabellate form from 10 to 15 mm. in thickness, and about 230 mm. in greatest breadth. The excurrent orifices are situated along the outer border in a single row. Each orifice in the specimen examined corresponded to a fistular swelling which rose like a ridge on the side. These ridges run together below, so that many of the excurrent canals are thus traceable throughout their larger ramifications. The structure is very dense, the surface smooth, the fibres small, and the mesh of the tissue exceedingly fine.

Loc., Phillip's Island, Australia, in Soc. Coll.

Variety *palmatiformis*. This variety has an aspect not unlike that of *Spongelia palmata*, owing to the thinness of the colony which permits the light to pass through quite freely. The primary fibres are, however, closely approximated, and besides the ordinary secondary fibres the peculiar open network of connecting tissue which distinguishes this species from *Spongelia rectilinea* is also present. This consists of a very fine net-like conjunction of threads finer than the secondary fibres, which connect the primary fibres sometimes horizontally and sometimes vertically. The incurrent orifices in both varieties are small and plentifully scattered over the surface, which has a peculiarly dense and smooth aspect on account of the prevalence of this connective tissue.

***Spongelia rectilinea* Hyatt.**

Variety *irregularis*. One of the specimens examined (Pl. xvii, fig. 15a) is a sessile, but irregular mass, which may have been two complete branching colonies which have coalesced, or a very porous colony with a double base. The hollows running through the mass are so regular that they might have arisen in this unusual way, though it is more likely that they are the natural accompaniment of the growth of the mass. The principal characteristic is the smoothness of the surface of the skeleton and the distinctness of the primary fibres in the interior, which are loaded with pebble dust. The mesh is coarser than

¹ This species is respectfully dedicated to Prof. W. G. Farlow, to whom the author feels deeply indebted for the interest he has shown in this Memoir, and the important assistance he has given.

in *Spongelia Farlovii*, and the aspect of the surface rougher. The incurrent orifices are not specially distinguishable in the skeleton, owing to the fact that the connecting tissue does not so uniformly fill up the cells formed by the primary and secondary fibres. The excurrent orifices are about a line only in diameter, much smaller than in *Farlovii*, and irregularly peppered over the surface.

Loc., Phillip's Island, off Port Phillip's Head, Australia, in Soc. Coll.

Variety *tenuis*. One specimen (Pl. xv, fig. 13) has a slightly coarser skeletal texture than *irregularis*, and the form is regular and vase-shaped. The external surface is pitted and seamed by deep depressions. The internal surface is pierced by numerous excurrent orifices of small size. The primary fibres project but very slightly, and the whole is remarkably smooth. Another specimen of this variety existing in the Philadelphian collection has a similar form, but the outside of the cup is supplemented by two incomplete vase forms, budding from the base. Another specimen has a vase-shaped form, with a skeleton not quite so dense as in the first, but still very closely approximates to the same condition and surface, with precisely the same characteristics in the interior, where it was in perfect preservation.

Loc., Phillip's Island, Australia, in Soc. Coll., and near Sydney, New South Wales, in Acad. Nat. Sc., Philadelphia.

Variety *erecta*. This variety differs somewhat in the texture of the skeleton from *tenuis*. It is not quite so coarse, but it otherwise resembles it quite closely. The shape (Pl. xvii, figs. 12, 13) is quite distinct, being almost fistulose, and the exterior very deeply pitted. The inside of the cup is very shallow.

Loc., Phillip's Island, Australia, in Soc. Coll.

A specimen in the Collection of Peabody Academy from Swan River, Australia, is a tall, pedicellated, flabellate form, with numerous orifices on the upper edge. These, as in *Spongelia densa*, correspond to ridges which follow the directions of the internal channels. This form and these ridges give considerable similarity to *Spongelia densa*, but the skeletal structure is distinct, and like that described above.

***Spongelia palmata* Hyatt.**

This species (Pl. xvii, fig. 15) is remarkable for the looseness and fineness of the skeletal structure. The form in the variety figured is flabellate, with a broad and very flat pedicle. The upper edge is, as usual, occupied by the excurrent orifices. There are ridges running from these and corresponding to the excurrent canals, but they are not very prominent. The texture is so loose that the light shines through all parts except the extreme lower part near the pedicle, where the tissue becomes very dense and hard. The primary fibres are not so coarse as in *Spongelia Farlovii*, but much more widely separated, and the connecting tissue of secondary fibres has a much larger and more irregular mesh. There is no appearance of net-like connecting fibres, and the tissue is so irregular that it is difficult to detect on the surface the usual polygonal cells of the genus.

Loc., Pacific Ocean, U. S. Ex. Exp., in Yale Coll.

Two other specimens, one in Coll. Acad. Nat. Sciences, Philadelphia, and one in the Society's Collection, agree with the description given above very closely, but there is a considerable variation in the surface. The largest is a foot broad by nine inches in height, and

the surface is pitted with shallow depressions or hollows about one half of an inch in diameter.

Loc., New South Wales, near Sydney.

Another form precisely intermediate in texture between these and variety *poculata*, also occurs in Coll. Acad. Nat. Sciences, Philadelphia, from Cuba. The form is a flattened cup-shape, with numerous depressions of similar flattened form on the sides; some of these are so deep that they are really smaller flattened cups, without, however, showing fistular orifices at the bottom of the depressions.

Variety *poculata*. This variety has a denser skeleton than the typical specimens of this species, but this is due to the closer approximation of the primary fibres, and not to any increase in the size, nor to any great change in the arrangement of the fibres. The form is fistulose, but the cup shallow above. The exterior is deeply folded, but otherwise the surface is smooth.

Loc., Phillip's Island, Australia, in Soc. Coll.

Variety *infima*. This variety is shown by one specimen, locality unknown, but probably New South Wales. It is in the Collection of the Academy of Natural Sciences of Philadelphia, and is a fragment composed of distinct branches more or less completely joined along their outer edges, forming a partially flabellate specimen. This is also very interesting, in so far as it probably shows one of the steps in the growth of the flabellate forms. It suggests the idea that these are primarily due to the lateral anchylosis of a certain number of branches growing in the same plane, but a more complete suite of specimens is necessary in order to test this view.

***Spongelia enormis* Hyatt.**

This species can be distinguished by its peculiar surface and internal structure. The fibre is rather harsh and unyielding, but not wholly inelastic. The form is flattened, flabellate, manner of attachment uncertain. Excurrent apertures are all of small size, but very numerous and situated on the lateral ridges, not, as usual, in the channels. These lateral ridges are merely slightly raised above the surface, and about 3 mm. or so in breadth. They run in lines radiating from a central axis outwardly, and are ornamented by projecting bunches of fibres, in which, however, the single primary fibre at the centre is hardly so prominent as is usual in *Spongelia*. They, in fact, resemble those of *Spongia*, in which the primary fibre is often surrounded and concealed by a bundle of bent secondary fibres. In the interior, however, the singleness of the primary fibres may be easily determined, so that there can be but little doubt of the true affinities of the species. The primary fibres, however, are very crooked, and are consequently almost indistinguishable from the irregular network of secondary fibres. There is no apparent order of arrangement until the section is seen by transmitted light, then thick confused lines of radiating primary fibres appear. This aspect is enhanced by the sharp angle which the secondary fibres make at their junction with the primaries, their great number and close distribution.

The channels on the surface are shallow, very numerous, and about as wide as the ridges, and are not pierced by the larger apertures. In fact their existence, and those of the ridges, is probably entirely due to the peculiar linear arrangement of the small excurrent apertures and their accompanying tufts of fibres, which serve to elevate the surface in corresponding ridge lines, and leave the general surface of the sponge depressed. This is the only way to account for this otherwise exceptional structure, since in almost all cases

the channels of the surface in a sponge are essentially the product of the sub-epidermal horizontal canal system, and serve as lines of communication with the neighboring vertical canals.

Loc., Mauritius, in Coll. Mus. Comp. Zool.

***Spongelia anceps* Hyatt.**

This form, of which I have only seen one specimen, is remarkably distinct from any species here described. It closely resembles *Spongelia Kirkii* in appearance, but differs in the aspect of the fibre, which is not so coarse, and the generally finer look of the skeleton. There is also no net-like connecting tissue as in *Kirkii*, and I separate them on this account. The cells, also, are very regularly formed, the primary fibres regular and single, and the secondary laid up between them in the most regular manner. It is the very type of a Spongelian.

Locality unknown ; in Coll. Acad. Nat. Sciences, Philadelphia.

***Spongelia ligneana* Hyatt.**

This species is allied to *Spongelia dubia* in general appearance, owing to the smooth aspect of the surface. It has, also, an exceedingly dense skeleton and a very small mesh between the fibres. The primary fibres project slightly above the surface in single points, and the whole is exceedingly hard and harsh to the touch. The fibres are very coarse, and the primary fibres very opaque, and also loaded with débris. A singular appearance is given to all the fibres by the abundant development of the concentric layers of keratode which surround the primitive cores. These last are quite transparent, so that under the microscope the effect is that of a hollow fibre, until the double outline or end view shows their solid character. The fibrous structure of the darker external part is also particularly noticeable.

Loc., Zorritos, Peru, in Yale Coll.

***Spongelia Kirkii* Hyatt.**

Dysidea Kirkii? Bow., British Spong., Vol. I, p. 212.

The single specimen (Pl. XVII, fig. 19) examined possesses the coarsest skeleton of any species in this genus. The primary fibres are very thick, inelastic, and loaded with foreign matter. They project considerably beyond the surface, and the quantity of foreign matter in them gives them a peculiar whitish granular aspect. The connecting secondary fibres are a dark horn color and excessively large, especially in the older parts, such as the pedicle. They are also very widely separated, and more inelastic than the primary fibres. The result of this structure is an exceedingly open skeleton, through which you can see with ease, but which cannot be compressed in the slightest degree without breaking the fibres. The form is thick, erect, and irregularly flabellate, but the excurrent orifices are irregularly distributed on the top and sides, and, in fact, are hardly distinguishable at all upon the skeleton. The pedicle is thicker than the upper parts, and very much harder. In the lower parts of this pedicle the connecting tissue has become very dense, presenting quite a cellular aspect for considerable spaces, owing to the number of extra fibres secreted.

The resemblance to *Dysidea* in the skeleton is so close that only one characteristic separates it, the exclusion of the foreign matter from the secondary fibres.

Loc., Phillip's Island, Australia, in Society Coll.

Variety *Floridiensis*. Two specimens of dendritic forms exist in the Coll. Mus. Comp. Zoology, which can be referred only to this species. The fibres are not so much loaded with débris, but in other respects they resemble the oldest, densest and coarsest parts of the Australian form.

PHYLLOSPONGIADÆ.

This family contains sponges which, instead of growing up into solid heads, as is habitually the form of the Spongiadæ, are apt to form leaf-like or frondose stocks. These are more or less complicated in pattern, owing to the anastomosis of the fronds wherever they come in contact, and occasionally head-like colonies are thus produced. These, however, retain the frond, or leafy aspect, in the arrangement of the internal parts of the skeleton, as in *C. vermifera*. Many of the species are perforated, but this is a characteristic not yet understood, and therefore of doubtful value. The fibres of the skeleton usually radiate outwardly from one or both sides of a central mass or layer of fibres which have an irregular mesh without pronounced primary fibres. Fibres may be either very regular, as in *Spongelia*, or very irregular, or absent altogether. Otherwise they are precisely similar to those of the Spongiadæ, though not ordinarily so elastic. They differ from those of the Hirciniadæ in these characteristics and in the absence of foreign matter from the secondary or connecting fibres.

CARTERIOSPONGIA, gen. nov.¹

The species which represent this genus are so remarkably different from all others that I have ventured to consider them as distinct. The form of the young in the species described is probably flabellate, but speedily becomes irregular, with numerous flabellate branches, which still farther complicate the aspect of the specimen by anastomosing among themselves. The aspect of the whole is thus rendered almost like that of a truly solid head, but on examination one sees the wide irregular cells between the network of flat branches and the leaf-like aspect of the branches themselves. The fibres are of medium size, like those of the Spongiæ, but are arranged externally like those of *Spongelia*, and with considerable regularity. *Spongia lamellosa* Esper may possibly belong to this genus. The microscopical structure is very similar in Ehler's preparation, and the external aspect of Esper's figure quite like that of *Carteriospongia perforata*, with the exception of the holes piercing the fronds.²

A difference in the mode of growth would ordinarily be of small taxonomic value, but one such as is described above, and in combination with peculiar skeletal characteristics, could hardly be associated in the same genus with the solid, or even branching heads of true *Spongia* or *Spongelia*. *Phyllospongia* alone approximates to this genus, and its true position may possibly be nearer to this remarkable group than our present information would lead us to suspect. This appears in *C. Madagascarensis*, which very closely resem-

¹This genus is dedicated to Dr. H. J. Carter of the British Museum out of respect for his long continued and successful labors upon the natural history of the Poriferæ.

²The curious form, figured by Esper, and described as *Spongia penicillata*, is also an undoubted species of this genus. Loc., India.

bles *Phyllospongia* in its general aspect. On the other hand, an equally close approximation to true *Spongia* is to be observed in the softer and more pliable fronds of *C. perforata*, which might readily be mistaken for a true Spongian form.

***Carteriospongia Otahitica* Hyatt.**

Spongia Otahitica Esper, Pflanz., 2, 270, pl. 44.

“ “ Ellis and Solander, pl. 59.

This curious species is singularly uniform in the aspect of the surface, and the specimens, all of which are from Zanzibar, have the leaf-like or palmate form. This seems rarely to be single; in most cases the leaves of neighboring colonies seem to anastomose, so that nearly every colony is supported by several stems. Both surfaces appear to be similar at first sight, but they are quite distinct. The outer side in perfect specimens is ribbed, like the inner, but the ribs, or longitudinal ridges, are thinner and longer than those on the inner or upper side. The latter have a more luxuriant growth and a more tufted aspect. Between these minute ridges the wall of fibres is thin, and pierced by rows of holes.

The primary fibres are in fascicles, and overloaded with débris. The mesh, where it can be seen, is regular, as in other species of this genus. The preparation of the fibres of the original of *Caccospongia lamellosa* Ehler has been compared, and shows great differences. The primary fibres are single and loaded with débris, but the mesh is quite similar to that which is usual in this genus, especially as regards its regular form and the thickness of the secondary fibres. These differences, though considerable, might occur in the same species, especially if one lived in clear waters, and the other in a place where there was much floating matter. It is very evident, however, that there are no holes through the fronds in *lamellosa*, and that the whole surface is not cut up by discontinuous ridges as it is in this form.

Loc., Zanzibar, in Soc. Coll., and in Peabody Academy, and Yale Coll.

Variety *aplanata*. This precisely resembles the preceding, but the ribs or ridges are depressed and thinner, and the surface is finely channelled.

Loc., Madagascar? in Soc. Coll.

***Carteriospongia radiata* Hyatt.**

This species closely resembles *C. Otahitica* in general appearance and mode of growth, but is easily distinguished from it by the smoothness of the surface on both sides. The surface, also, instead of being evenly hirsute on the upper side, as in *C. mystica*, has a veil composed of minute fibres, which bridge over all inequalities of the interior, and conceal the longitudinal ridges which are formed internally. The primary fibres are single and pointed, but project slightly above the veil and are evenly distributed. Upon the lower or outer side no veil is found, and it differs from the upper or inner side in its loose texture, which allows the primary fibres to be seen, and in the figures made by the superficial canals. These radiate from a central, large pore, which represents the cloacal aperture, and form numerous star-like or dendritic figures in the surface of the skeleton. The interior is completely honeycombed by canals throughout the upper half of some leaves, while the lower part, the stems, and the younger sponges, are solid. Whether this is due to parasites or not, is uncertain. The microscopical structure is similar to that of *Sp. lamellosa* Esper, but the fibres are much larger. There is also a notable

absence of primary fibres in transverse and longitudinal sections, and the centre of the entire frond is apparently opaque with sedimentary matter. This opacity, however, is shown upon close examination to be largely due to the great irregularity of the mesh and the density and thickness of the fibres. From this denser centre the primary fibres radiate outwardly to either side; but even these are so tortuous that it is difficult to follow them.

Loc., Zanzibar, in Coll. Peabody Acad., Yale Coll., and Soc. Coll.

Variety *complexa*. This variety grows in clumps composed of small fronds resting on many stems, as in the Zanzibar specimens, but the radiating, surface canals are not formed as in the typical variety. The oscules are numerous and very small, and the canals radiating from them are equally minute, and are therefore hardly perceptible. Close observation, however, makes it apparent that the oscules have the same structure as in the typical form, and many of them show a decidedly stellate outline. In certain specimens the fronds are fewer and larger, and these lead into the next variety.

Variety *Dulsiana*. This form is easily separable, and may be readily distinguished from the preceding by the form and the absence of any large oscules. The latter are numerous on the veiled side, but are very minute, and never stellate. The veil, as in the case, also, of some specimens of variety *complexa*, may be present on both sides of the frond. The form rests upon a stem which branches above, dividing into numerous flattened fronds, which spread outward in the same plane. These broaden as they grow, so that the whole colony has precisely the aspect of the common dulse, *Rhodomenia palmata* Grev. The color of the skeleton is yellowish white.

Loc., Madagascar, in Soc. Coll.

Carteriospongia Madagascarensis Hyatt.

This variety, of which I possess only one specimen, is perfectly white, and the fibres transparent. The texture and the structure of the skeleton is closely similar to that of *C. lamellosa*, even to the manner of the arrangement of the primary fibres, and the way in which the débris is arranged, and it is also imperforate. It differs from the latter, however, in the absence of all pores, ridges, or marks of any kind, both surfaces being perfectly smooth; even the primary fibres do not project. There is also no veil, the mesh of the skeleton being about equally close and dense throughout. Here and there on the outer side, this dense aspect gives way to an exceedingly fine ribbed aspect, due to the arrangement of the internal skeleton in ridges with surface channels between them. On the inner side there are numerous small pores precisely similar to those of *Phyllospongia*, but the aspect of the internal structure of the skeleton is quite dissimilar, as is also that of the surface when examined with a magnifier. The form is similar to that of *C. perforata*.

Loc., Madagascar, in Soc. Coll.

Carteriospongia vermifera Hyatt.

This species is represented by only two specimens, and neither of these has the oldest part or base of the colony preserved, therefore it cannot be positively said that it was flabellate, though there is every indication that this was the case; the branches are all radiatory, as if derived from a small base. The anastomosing of the branches is more regular than in *Carteriospongia perforata*, and more complete, but there are no horizontal floors

between the branches. The branches, also, are solid, and have none of the perforations or ribs observed in *Carteriospongia perforata*, and are about one-twelfth of an inch in thickness. The fibres of the skeleton, however, appear to be of about the same degree of fineness in both, but the aspect of the surface in this species is very similar to a section of wood made through the burrows of the ship worm, whereas no such comparison can be made with *C. perforata*, the cells being much too irregular in size and shape.

Loc., Phillip's Island, Australia, in Soc. Coll.

***Carteriospongia perforata* Hyatt.**

The single colony examined is a flabellate branch arising from a narrow base. This throws off other branches as it rises, which anastomose in a most irregular manner. They are ribbed longitudinally with branching, continuous ridges, between which are numerous round or elliptical openings, which penetrate to the opposite side. The branches are, in this specimen, about one-eighth of an inch in thickness.

Loc., Phillip's Island, Australia, in Soc. Coll.

***Carteriospongia? mystica* Hyatt.**

The specimen upon which this species is founded, like all the Australian keratose sponges which have come under my observation, is of an exceedingly dark color, the ordinary red-brown. So distinct is this color and the hard woodeny aspect, that an observer can usually pick out specimens from this region without difficulty, though this rule has its exceptions, since there are always some among a large lot of West Indian specimens which are quite as dark colored internally, though perhaps never quite so deeply tinged on the exterior; whereas in Australian sponges the reverse is not infrequent, the internal parts of the skeleton being lighter colored than the exterior. The fronds in this specimen have combined into an irregular cup-shape with several supporting stems, so that it cannot be said whether the whole is from one frond, or the anastomosis of several neighboring fronds. The interior is perfectly smooth or rather even, for the primary fibres rise above the surface forming a pile or beard, which is quite perceptible without the magnifier. The pores are numerous, and there are no surface channels. These, and the cloacal ostioles, occur only on the exterior, a reversal of their customary distribution in this sub-order. This characteristic is also found in *Sp. lamellosa*, and in fact the enlarged portion of the outer surface, as figured by Esper, is very similar to the aspect of this sponge, except that the oscules usually lie at the point of junction of a group of more or less radiating canals. I am obliged to consider the determination of the genus as very doubtful; it may prove to be a true Spongian upon farther investigation, allied to, or identical with, *Sp. lignea*.

Loc., Adelaide Islands, So. Australia, in Yale Coll.

PHYLLOSPONGIA.

***Phyllospongia papyracea* Ehler.**

Phyllospongia papyracea Ehler, Die Esper'sch. Spong. Erlangen, 1870, p. 30.

The peculiar form of the species (Pl. xvii, fig. 31), which alone represents this group, is unique. It is flat, like a leaf, and looks and feels like an extremely coarse, thick paper. The surface is dense, owing to the net-like anastomosis of the finer intermediate fibres of

the skeleton, and the accumulation of foreign materials, fine particles of sand, foraminiferae and broken spicules, etc. When held up between the observer and the light, numerous small canals radiating and branching from the base reticulate the interior. These are penetrated by numerous closely adjoined incurrent pores. The excurrent pores are all on the upper side and of various sizes, though none very large. The accumulation of foreign matter is also much less on the lower side, so that the reticulated aspect of the surface can be observed. The longitudinal threads are radiatory, but are irregular in size and shape, and loaded with spicules and foreign material.

The connecting or secondary set of fibres are not placed at right angles to the primary, but are very irregular. They do not differ greatly in size, and are so slightly colored as to be almost perfectly diaphanous when mounted in balsam. They are also nearly completely free from foreign matter. Besides these, there is still another system of extremely minute fibres connecting both of the former irregularly with a fine network similar to that found in *Stelospongos*, but differing in its want of regularity and the manner in which it permeates the whole structure. These characteristics are wholly Spongian, and do not seem to confirm Ehler's conclusion that it is a form closely allied to *Chalina*, though they justify his description of the form as a distinct genus. Ehler considers that Esper's *Sp. plicata* shows considerable affinity for this group in its characteristics, but of this I have never seen an example, or even Esper's figure.

Loc., Cape of Good Hope, in Ward's Museum and in Soc. Coll.

HIRCINIADÆ.

The great contrast presented by the aspect of the skeleton in this family as compared with that of either the Spongiadae or Phyllospongiadae, would justify a separation independently of more minute structural differences. There is not that distinction between primary and secondary fibres which is to be found in the two preceding families. When debris is present in the water the fragments, which must have been derived from the dermis, are not confined to the core of the primary fibres alone, but are equally prevalent in the secondary fibres, showing that they must have been formed by the same layer of the dermis as the primary fibres. Both classes of fibres, also, are sarcodous or gelatinous, and are readily dissolved in some specimens by maceration in cold water. They are also flatter in form, and have a fibrous aspect when dried, in some species due probably to this flattening.

Dysidea approximates most closely in the color and aspect of the fibres to those of *Spongia*, but can never be mistaken for a true Spongian, though the fibres evidently possess more keratode than those of any other species in the family. The forms of the specimens are similar to those prevalent among the Spongiadae, dendritic, solid, flabellate, fistular and cup-shaped, but never frondose, as in the Phyllospongiadae.

DYSIDEA Jolnst.

Spongelia (pars) Schmidt and Bowerbank.

The skeleton in this genus, as in the single species which appears to represent it in Florida, appears to combine the characteristics of several genera. The primary fibres are large and sometimes partially compound, as in some species of *Stelospongos*; the secondary fibres partly like those of *Spongelia* and partly like those of *Hircinia*. Not only are the primary fibres loaded with foreign material, as in *Spongelia*, but the secondary, also, and

besides this the membranes everywhere, and the internal portions of the sarcode. This characteristic therefore has greater significance than in any other species, and justified the retention of the distinct generic name of *Dysidea*.

***Dysidea fragilis* Johnst.**

Dysidea fragilis Johnst., Brit. Spon., p. 286.

Dysidea fragilis Bow., Brit. Spong., p. 381, pl. 13, 14.

This species (Pl. xvii, fig. 17) resembles Johnston's *Dysidea fragilis*, but evidently has a much coarser mesh, and probably grows larger. Its color when living is not known. Otherwise the specimen corresponds quite closely to the descriptions of Johnston. The skeleton (Pl. xvii, fig. 18) is similar to that of *Spongelia*, but presents characteristics which ally it closely with *Hircinia*. There is a tendency to branch in the primary fibres, and they are often compound. The secondary fibres are sometimes single and hairy, and sometimes composed of the usual mass of cellular or perforated fibres as in *Hircinia*. The membranes are loaded with foreign materials, and so also are the primary and secondary fibres, with the exception of the single dark horn-colored ones alluded to above. The surface is rather rough, with the slightly projecting points of the primary fibres covered with hardened sarcode. The whole mass when dried is very light and porous, and of a flat, tabulate shape. The excurrent orifices are few and rather small. When carelessly dried these entirely disappear, and the specimens become very hard.

Loc., Zanzibar, in Coll. Peabody Academy; Biscayne Bay, in Soc. Coll. Specimens in the Coll. Mus. Comp. Zool. are named *Spongelia*? by Schmidt.

HIRCINIA Nardo.

Filifera Lieb.

Sarcotragus Schmidt.

Polytherses Duch. et Mich.

This genus is peculiarly liable to the attacks of a seeming parasite, which forms a filamentous tissue often connecting all the fibres of the sponge with a sheet-like net-work. The filaments disappear in a completely macerated sponge, or if present, present a hollow tubular aspect with a bulb at one end, as figured by Schmidt. In less completely macerated specimens the contents are visible in the interior of the threads, and are broken up, looking in some specimens like cells. This may be erroneous, but certainly these threads are not constituted like regular sponge fibres, and are probably parasites of some sort, but whether *Algæ* or not, it is difficult to determine.

Carter describes it as an *Alga*, under the name of *Spongiophaga communis*, and says that he has found it in other sponges than *Hirciniæ*. Neither Schmidt nor others have, however, quoted any similar instances, nor has Carter given the names of the other species. Schmidt is evidently very doubtful, but is inclined to the same view as Kölliker, that the filaments are distinct elements from the fibres, and this is also my own impression. The filaments are much larger than the fibrillæ, the color and aspect when dried distinct, and the former never have the little bag on the end.

Dr. W. G. Farlow, the well known Algologist, has had dried specimens under examination, and reports to me that he finds no sure grounds for referring them to Algæ, or any plant structure, and examinations of the living sponge will probably be necessary in order to determine the exact nature of these threads. The extremely thin, sheet-like arrangement of the fibrillæ of the connecting fibres in many species adds to the difficulty of separating the filaments from the fibrillæ.

The fibres are composed of fibrillæ, or threads of horny-colored appearance. These are bound together in bundles to form the primary or vertical fibres, and are more or less spreading, or fan-like, especially at their bases; when modified by the connecting tissue, the horizontal fibres sometimes spread into complete screens, even when entirely freed from the parasitic filaments. Both systems of fibres are usually loaded with foreign matter, and often this is so purely composed of spicules as to lead to curious blunders. Duchassaing and Michellotti's reference of this genus to the siliceous sponges is due to this, and I have seen one specimen inseparable from a true *Chalina*, either in the form or arrangement of the spicules. The epidermis is remarkably thick, and usually loaded with foreign matter, but when partly free from this, or partially macerated, exhibits certain peculiarities. The skin entirely covers the points of the primary fibres as a rule, but when they protrude it is seen that they are often composed of several fibres, or bundles of fibrillæ. From the terminations of these there spreads out an extensive epidermal network of secondary fibres, the close association of which with this external membrane explains the load of foreign matter which they bear.

Hircinia campana Nardo, Isis. 1833-34.

Spongia campana Lamarek, Anim. sans. Vert., 2d ed., vol. 2, p. 364.

Filifera campana Schmidt, Spong. d. Atlant. Gebietes, p. 30.

Polytherses campana Duch. et Mich., Op. cit., p. 68.

Variety *typica*. The normal variety of this species is vasiform (Pl. xv, fig. 19). It may be either ribbed externally, or smooth, with of course the exception of the projecting spines composed of the bundles of vertical, primary fibres.

Variety *fixa* Duch. et Mich. This is the same as *typica*, but the vase is open on one side (Pl. xvii, fig. 28). I have examined complete series of this and of the normal variety, and though they are distinct forms, there are many intermediate forms, and one specimen has one side open below, showing that it began life as variety *fixa* and ended it as one of the normal variety. One specimen of this variety in Mus. Comp. Zoology, is reported from 40 fathoms off Conch Reef, Fla.

Some specimens of both of these varieties have peculiar outgrowths of certain parts. These may take place externally and surround the cup with a hedge of branches, or within, giving rise to single projecting branches of greater or less length. Again this tendency to branch may be accompanied by a thickening of the walls, which if carried out fully would entirely change the hollow vase to a mass with many radiating or erect branches at the top. In all of these varieties the larger apertures are within, and the smaller without.

Variety *felix*.

Polytherses felix Duch. et Mich.

This variety is similar to the young of the last described before it begins to assume the vase form. It is short and clumpy, with orifices on the upper side, which may either be numerous, or single. The bundles of fibres project above the surface more than in

campana, and are decidedly larger. Those that have only one or two orifices are really fistular, but lead into solid forms with projecting orifices. They may be single, or multiple to such an extent as to form large masses, and they may also be truncated, or furnished with projecting excurrent tubes. The branches springing from the typical vase-form are flattened, and they precisely resemble the flabellate forms in structure and aspect. These may be either as described by Duch. et Mich. in their "Spong. de la Mer Caraïbe" branched above like *P. armata*, or with an entire border, as in *P. tristis*, *ignobilis* and *linguiformis*, or with a semicircular form and a line of orifices above, as in *P. marginalis*.

The modifications of form, in fact, seem almost endless, including also those like *P. columnaris* (Pl. xv, fig. 17) and *P. cylindrica* Duch. et Mich., which are composed of stout branches. There are also numerous variations of all these, and some colonies which may be considered amorphous (Pl. xv, fig. 18), in so far as they appear to be composed of branches irregularly soldered together, and having several points of attachment. The extent and accidental character of the variation make them exceedingly difficult to classify, and I have not been able to distinguish some of them in a satisfactory manner. These variations are not confined to the form, but extend also to the skeletal tissue, which may be either excessively coarse and open, with a rough surface and large spines, or quite fine and close in structure, with smoother surface and very slight spinous projections. The sunken interspaces between the spinous projections may be from 2 mm. to 10 mm. in diameter. The general size is about 4 or 5 mm. According to Dr. Palmer, this species is not difficult to dry, and retains its form on account of the density and comparative elasticity of the skeleton. The interior in alcoholic specimens is usually very porous and open, owing to the numerous canals and slight development of the mesoderm, but in some specimens quite a fleshy aspect is assumed, though the mesoderm is never very solid. Color when living is black, when dry reddish brown, or white.

Loc., Nassau, Key West, Biscayne Bay, in Soc. Col.; Havana, in Mus. Comp. Zool. Coll. Habitat, reef in 4-10 ft. of water for the normal variety. Whether the other varieties also occur in the same depth of water, was not stated by Dr. Palmer.

Besides the above, there exists in the Coll. Acad. Nat. Sciences of Philadelphia a remarkable variety. There are two specimens, the tallest about three inches, of slender, irregular, branch-like forms, but consisting each of a perfectly fistular tube with very thick walls. This appears to complete the remarkable cycle of varietal forms, which are represented in this species, and which might very reasonably be described as many distinct species, on account of the extraordinary characteristics found in the skeleton, which often differs in texture as much as the varieties differ in form. I have not, however, succeeded in finding any constancy in the skeleton of any special form, or series of forms, the texture appearing to be independent of the form. A thick lump-like form of this or a closely allied species, has also been collected at La Paz, Lower California, and presented to the Society by Mr. W. G. W. Harford, and two specimens have been received from the Peabody Academy, Salem, from Zanzibar, which do not seem to differ from the ordinary type of the skeleton, except in the quantity of contained sediment, this being less than is usual in Florida specimens. Mr. Goode also sends nearly all the described varieties from Bermuda, so that it would appear to be cosmopolitan in distribution.

Hircinia arbusculum Schm. (Mss.)

I find a specimen in the Museum of Comparative Zoology, named by Schmidt *Hircinia arbusculum*. It seems to be a good species, and therefore I adopt the name, although I can find no corresponding description, or even mention of the specimen in Schmidt's works. The half dozen specimens examined were all from Kingsmills Islands. They are composed of irregular, somewhat flattened and constantly anastomosing branches. The surface is finer and smoother than is customary in *Hircinia campana* in the most extreme variations. The skeleton corresponds to the surface, and is also extremely fine, as compared with the last mentioned species. The color of the dried specimens is light, as in *H. campana*, but the parasitic alga was not present in the single specimens examined with the microscope.

Hircinia acuta Hyatt.

Polytherses acuta Duch. et Mich., Spong. de la Mer Caraïbe, Verhand. Maatsch. et Wetensch., Haarlem, 1864, 21-2, p. 72, pl. 13.

This form (Pl. xv, fig. 20) is distinguishable from others by the large size of the projecting fibres, the thick, tough skin covering them, and the large size of the spaces between the spinous projections. The form of the specimens examined was rotund, the top alone occupied by the numerous excurrent orifices, which were gathered together in one or two sieve-like patches. The sunken spaces between the spines are from 5 to 15 mm., or even 20 mm. in diameter.

This is one of the so-called Logger-Head Sponges, and emits during the process of maceration or drying an almost unbearable stench. The largest seen, according to Dr. Palmer, was about four feet in diameter and one foot high. The fibres are not at all elastic, and so loosely interwoven that when artificially macerated, the skeleton will entirely melt away if not closely watched and delicately handled. The specimen figured, Pl. 17, fig. 26, could have been all washed away by pressure, so soft were the fibres after forty-eight hours' immersion. When being dried they must be constantly turned, or they will soften, looking like melted rubber, according to Palmer, and lose entirely their normal form. Color when living, according to the same observer, very dark gray externally, and black internally. The dried specimens become much lighter, a dark drab of a purplish shade. Internally this sponge is remarkable for the large size and number of the canals, which are not indicated upon the surface, and which render the whole structure very light. Habitat, reef, in 8 feet of water.

Loc., Nassau, in Soc. Coll.

Variety *filamentosa*. These specimens I at first supposed to be distinct, but after the maceration of one specimen of *H. acuta* I was struck by the close resemblance of the skeletons. The three dried specimens examined have a very open structure, but the skeleton is so completely covered by the filamentous tissue that it is hardly possible to see any part of it distinctly. The interior is exceeding hollow, or rather cellular, the hollows being separated by thin walls of the filamentous tissue, within which lie the fibres of the true horny skeleton. These skeletons are therefore of the most paper-like structure and extreme porosity. The primary fibres project in large tufts beyond the surface.

Loc., Cape Florida, in Soc. Coll.

Variety *nigra*. This form (Pl. xv, fig. 21) is apparently intermediate between *Hircinia acuta* and the solid varieties of *Hircinia campana*. The exterior has considerable resemblance to the varieties of the latter with a coarse surface, but the structure is more papery, the spinous projections readily yielding to the touch even in the most carefully dried specimens. These spinous projections are also shorter than in *H. campana*, and much smaller than in *H. acuta*. The epidermis is more destructible than it is usually in *H. campana*, and therefore very distinct from the coarse persistent epidermis of *H. acuta*. The skeleton, however, has the same open structure and want of elasticity also observed in *H. acuta*, so that, as stated by Dr. Palmer, the greatest care must be taken in drying in order to preserve the form. The shape is the same as in *H. acuta*, and the arrangement of the excurrent apertures similar, but less sieve-like. The interior, also, is cavernous, as in that species and in *H. filamenta*. The filamentous tissue is present, but not so abundant as in *H. acuta* or *filamenta*, and much more easily removed by maceration. Color in the living sponge black, in the dried form black to dark gray. Habitat, reef.

Loc., Biscayne Bay, in Soc. Coll., and Florida, in Mus. of Comp. Zoology.

Variety *longispina*.

Polytherses longispina Duch. et Mich., Op. cit. p. 71.

This form, of which I have seen but one specimen, is readily distinguished by the structure of the bundles of primary fibres. These are cylindrical bundles constructed, as in *Stelospongos*, of long primary fibres united by a secondary and rather closely set system of transverse fibres. In fact, so strong is the resemblance that it was at first classified with that genus. The intimate study of the fibres themselves, however, show that they belong to the *Hircinian* type, especially the broad membranous junction of the secondary with the primary fibres and their color. The intermediate filamentous tissue is also present, and helps to identify the species as a *Hircinian* form.

Loc., Havana, in Coll. Mus. Comp. Zoology.

***Hircinia cartilaginea* Hyatt.**

Spongia cartilaginea Esper, Pflanzenthier, vol. 3, pl. 64.

This form may be at once distinguished by the peculiar structure of the skeleton. The primary fibres broaden out before branching into exceedingly flat, flabellate fibres from one to three mm. broad. The branches then appear separated by a vesicular tissue of secondary fibres, the meshes of which are at first, when in the crotches of the branches, very round and minute, but gradually enlarge, and finally stretch from branch to branch of the fibre in the usual form. This of course is a characteristic of great variability, and often in the same specimen the observer finds quite an open tissue in some parts, and in others an almost closed network, and in some cases a continuous shelf stretched vertically between the vertical branches. The five specimens examined were completely macerated, and this may account for the absence of filamentous tissue.

Loc., Key West, in Soc. Coll., and Florida, Havana, in Coll. Mus. Comp. Zoology.

Variety *horrida*. One of the specimens examined is a bi-fistular form (Pl. xvii, fig. 29) with a skeleton partly of a curious pinkish hue, due to the bright colored foreign matter, fragments of *Corallines*, taken into the fibres from the epidermis. The mesh in the interior is exceedingly regular, consisting of broad, upright primary fibres, bound together by secondary fibres of a similar broad, flattened form, these again united by a vertical set of

short fibres, rendering the intermediate tissue vesicular. The primary fibres are all single, and generally colored a darker shade than the secondary fibres, which are often quite white. They project considerably as sharp, single spines, above the surface. The maceration of this specimen was very complete, the whole of the interior being encrusted with coral sand.

Loc., Cape Florida, in Soc. Coll.

Another specimen from Havana, in Coll Mus. Comp. Zoology, is intermediate in the character of the skeleton between the last and true "*cartilaginea*." In some parts of this the broad flabellate aspect of the primary fibres obtain, and they are arranged in lines, or ridge-like projections on the surface; whereas in other parts the primary fibres are single and with connecting tissue form regular, four, five or six sided cells, as in the Cape Florida specimen. The observer needs to be on his guard in the examination of this species, since in some specimens the spicules taken into the cores of the fibres, both primary and secondary are all of one kind and quite whole, except here and there where they have been bent too suddenly.

***Hircinia purpurea* Hyatt.**

Spongia rubens Duch. et Mich., Op. cit., pl. x, fig. 1.

This species is not the *Spongia rubens* as figured by Esper or described by Schmidt as *Pachychalina rubens*, but is unquestionably identical with the species described by Duch. et Mich. The specimens I have seen are all possessed of simple cylindrical branches, reminding one decidedly of the ordinary *Chalinula oculata* of this coast, both in form and in the aspect of the surface. This impression can only be dissipated by the minute examination of the skeleton. The fibres resemble those of *H. cartilaginea* in their flatness, the aspect of the horny matter which is essentially fibrous, the concentric arrangement of the fibres being in many cases hardly distinguishable. There is a peculiar irregularity in the shape of the fibre, due to the ridges formed in the centre by the greater shrinkage of the sides. The primary fibres are arranged symmetrically in a radiatory manner and somewhat widely separated; the secondary fibres are at right angles and connected by a horizontal series of fibres, which on the surface form a ditellian veil of a rather loose texture.

Dr. Palmer reports this sponge as habitually growing upon other sponges, corals or gorgoniae, and as quite uniform in its aspect. It dries readily, and the skeletons, even in specimens dried without being macerated, permit the light to pass through them, as in *Chalinula oculata*. The color when living is purple.

Loc., Florida and Nassau, in Soc. Coll.; Pacific Ocean, U. S. Ex. Exp., in Coll. Acad. Nat. Sciences, Philadelphia.

CERATELLADÆ.

Dr. Gray describes this family in the Proc. Zool. Society of London, in the volume for 1868, from two specimens which he respectively refers to two genera, Dehitella and Ceratella. They are certainly very remarkable sponges, and undoubtedly, in spite of their form and the extreme regularity of their skeletal structure, must be placed in the sub-order of the Sponginae. The fibres are solid, and contain no foreign matter, or spicules. The fibres are large in proportion to the size of the stems, and very closely united, so that it is difficult to distinguish them into primary, or vertical and secondary, or horizontal

connecting fibres. In fact, the structure, as stated by Gray, resembles quite closely that of the internal vesicular walls of porites, but is hardly so irregular. If, for instance, a stem be cut in section and viewed with the microscope, the vesicular openings arrange themselves in circles almost as regular as those in the spines of some Echinoderms. The primary fibres sometimes run together into a small, broad fibre, and these radiate from the centre.

Gray's discussion of the affinities of the two specimens betrays considerable doubt of the affinities of these sponges, and he appears to refer them to sponges as a provisional measure. There can be no doubt, however, that the structure of the skeleton of the apertures, with their irregular, internal, vesicular partitions, and the whole aspect, including the surface, which is striated with short, sinuous channels, has nothing coral-like in it; on the contrary, the whole is thoroughly sponge-like.

CERATELLA Gray.

DEHITELLA Gray.

The distinctions described by Gray between these groups are barely specific in importance, and certainly not generic. The species or form described below combines the characteristics of both genera. Some branches have the projecting spines and oscules only on the sides (Ceratella), while others have them all around the surface of the stem (Dehitella).

Ceratella labyrinthica Hyatt.

A single specimen from the Mauritius occurs in the Coll. of the Museum of Comp. Zoology. The base is solid, without oscula, much compressed, and smooth, in height about 50 mm., in breadth 38 mm., in thickness only 3 mm. From this flabellate base spring three equally compressed main branches, which give rise to several smaller branchlets and twigs. Of course as the size diminishes the branches are rounder, since the thickness remains about the same throughout. The youngest twigs are frequently, therefore, quadrate, with nearly equal sides. The oscula are on the sides of the larger branches, but are distributed on all sides of the branchlets and twigs. The spinous-like processes are confined, however, to the sides in nearly all cases, there being but few exceptions even on the twigs. These are not, as described by Gray, spines composed of primary fibres, but sharp elevations of the skeleton on the lower side of each osculum. The front and back of the branches and base are smooth, and under the magnifying glass have a close vesicular aspect. The color is a dark yellowish brown. A fine specimen also occurs from Cape of Good Hope, in Prof. Ward's collection, at Rochester, from which Fig. 30, Pl. XVII was taken.

NOTE. Two specimens, Pl. xv, figs. 22, 23, were introduced into the plates under the impression that they were species of Spongelia, but the microscopical examination of the skeleton showed them to be spicular. Subsequently I found a specimen identical in every respect with Fig. 22, which, however, had fibres free from spicules, and a new examination of the originals of Figures 22, 23 was made, disclosing the fact, that the perfect imitation of Chalina presented in my first preparation was accidental. This in its turn led

me to make renewed researches among the species of Tuba, and I now begin to think that I may be obliged to withdraw from the position taken in the first part of this paper, and admit Tuba as a genus of Sponginae. It is very remarkable that there should be any doubt on such a point; but although I have examined more than fifty microscopical sections of different species of Tuba, sometimes several preparations to a species, I cannot make up my mind as yet whether the spicules are indigenous or foreign.

EXPLANATION OF PLATE XV.

SPONGIA.¹

- Fig. 1. *S. officinalis*, sub-species *tubulifera*, var. *rotunda*. Loc., Nassau. See p. 513.
 2. *S. graminea*. Loc., Key West. p. 516.
 3. *S. discus*. Loc., Nassau. p. 514.
 4. *S. equina*, sub-species *gossypina*, var. *alba*. Loc., Nassau. p. 519.
 5. *S.* " " " var. *barbara*. Loc., Cape Florida. p. 519.
 6. *S. agaricina*, sub-species *dura*, var. *typica*. Loc., Nassau. p. 522.
 7. *S. equina*, sub-species *cerebriformis*, var. *typica*. Loc., Key West. p. 520.
 8. *S.* " " " var. *plana*. Loc., Key West. p. 520.
 9. *S.* " " " var. *caliciformis*. Loc., Key West. p. 521.
 10. *S. agaricina*, sub-species *corlosia*, var. *elongata*. p. 524.
 11. *S.* " " " var. *fusca*. p. 524.
 12. *S. lapidescens*, var. *turrita*. Loc., Bermuda. p. 527.

SPONGELIA.

- Fig. 13. *S. rectilinea*, var. *tenuis*. Loc., Australia. p. 537.

STELOSPONGOS.

- Fig. 14. *S. cribriformis*, var. *typica*. Loc., Havana. p. 531.
 15. *S.* " var. *stabilis*. Loc., Pacific Ocean. Yale Museum. p. 531.
 16. *S. levis*. Loc., Pacific Ocean. Yale Museum. p. 530.

HIRCINIA.

- Fig. 17. *H. campana*, var. *columnaris*. Loc., Key West. p. 547.
 18. *H.* " var. ——— " " p. 547.
 19. *H.* " var. *typica*. " " p. 546.
 20. *H. acuta*. Loc., Nassau. p. 548.
 21. *H.* " var. *nigra*. Loc., Biscayne Bay. p. 549.

TUBA.

- Fig. 22. *T. compacta*. Loc., Cape Good Hope. Ward's Coll. p. 551, note.
 23. *T. confusa*. " " " " p. 551, note.

EXPLANATION OF PLATE XVI.

SPONGIA.

- Fig. 1. *S. equina*, sub-species *gossypina*. This shows a piece cut out of the side of an aged specimen.
 p. 517.
 2. *S.* " " *meandriniformis*. Loc., ——— p. 519.
 3. *S.* " " *gossypina* var. *solitaria*. Loc., ——— p. 519.
 4. *S.* " " " var. *hirsuta*. Loc., Nassau. p. 519.
 5. *S.* " " " var. *porosa*. " " p. 518.
 6. *S.* " " " var. *dendritica* " " p. 518.
 7. *S.* " " " fistulose var. of *alba*. Loc., Bahama. p. 519.
 8. *S.* " coarse Mediterranean variety. p. 517.
 9. *S.* " Gerbis variety. p. 517.

¹ All the specimens figured are reduced to about one-fourth of the diameter of the original size.

- Fig. 10. *S. officinalis*, sub-species *tubulifera*, var. *solida*. Loc., Nassau. p. 514.
 11-11a. *S.* " " " var. *pertusa*. " p. 512.
 12. *S.* " " " var. *mollis*. " p. 513.
 13. *S.* " " " var. *exotica*. " p. 514.
 14. *S.* " " " var. *corlosiformis*. " p. 513.
 15. *S.* " " " var. *rotunda*. " p. 513.
 16. *S.* " " " piece of an aged specimen. Loc., Nassau. p. 509.
 17. *S.* " " " var. *prava*. Loc., Nassau. p. 513.
 18-19. *S.* " " *Mediterranea* var. *Adriatica*. Loc., Mediterranean. p. 511.
 20. *S.* " " var. *tubuliformis*. " p. 511.
 21. *S.* " " var. *mollissima*. " p. 511.
 22. *S. agaricina*, sub-species *Zimocca*, var. with irregular form. Loc., Mediterranean. p. 522.
 23. *S.* " " *punctata*. Loc., Nassau. p. 523.
 24-25. *S.* " " *dura*, var. *typica*. Loc., Nassau. p. 522.
 26. *S.* " " *corlosia*, var. *gossypiniformis*. Loc., Nassau. p. 524.
 27. *S.* " " *punctata*, var. *densa*. Loc., Nassau. p. 523.
 28. *S. equina*, " *cerebriformis*, var. *Mexicana*. Loc., Vera Cruz. p. 521.
 29. *S.* " " " var. *obscura*. Loc., Nassau. p. 521.
 30. *S.* " " " var. *caliciformis*. Loc., Nassau. p. 521.
 31. *S. agaricina*, sub-species *corlosia*, var. *fusca*. p. 524.

SPONGELIA.

- Fig. 32. *S. incerta*. Loc., Phillip's Island, Australia. p. 533.
 33. *S. spinosa*. Loc., Mauritius. p. 535.

EXPLANATION OF PLATE XVII.

SPONGIA.

- Fig. 1. *S. agaricina*, sub-species *corlosia*, var. *elongata*. Loc. Biscayne Bay. p. 525.
 2. *S. vermiculata*, var. *negligens*. Loc., Nassau. p. 526.
 3. *S. lapidescens*, var. *typica*. Loc., Havana. p. 527.
 4. *S. vermiculata*, var. *negligens*. Loc., Key West. p. 526.
 5. *S. lapidescens*, sub-species *Mauritiana*. Loc., Mauritius. p. 528.
 6-7. *S.* " " *dentata*. Loc., Havana. p. 528.

SPONGELIA.

- Fig. 8. *Sp. velata*. Loc., Zanzibar. p. 534.
 9. *S. dubia*. Loc. Nassau. p. 534.
 10-11. *S.* " var. *excavata*. Loc., Cape Florida. p. 535.
 12-13. *S. rectilinea*, var. *erecta*. Loc., Phillip's Island, Australia. p. 537.
 14. *S. Farlovii*, var. *densa*. " " " p. 536.
 15. *S. palmata*. Loc., Pacific. Yale Museum. p. 537.
 15a. *S. rectilinea*, var. *irregularis*. Loc., Phillip's Island, Australia. p. 536.

DYSIDEA.

- Fig. 17. *D. fragilis*. Loc., Biscayne Bay, Fla. p. 545.
 18. *D.* " Loc., Indian River, Fla. p. 545.

SPONGELIA.

- Fig. 19. *S. Kirkii*. Loc., Phillip's Island, Australia. p. 539.

STELOSPONGOS.

- Fig. 20. *S. Pikei*. Loc., Mauritius. p. 532.
 21. *S. Maynardi*. Loc., Key West. p. 529.
 22. *S.* " Loc., unknown. p. 530.
 23-24. *S. levis* var. *rotundus*. Loc., Phillip's Island, Australia. p. 530.
 25. *S. cribriiformis*, var. *stabilis*. Loc., Pacific. Yale Museum. p. 531.

HIRCINIA.

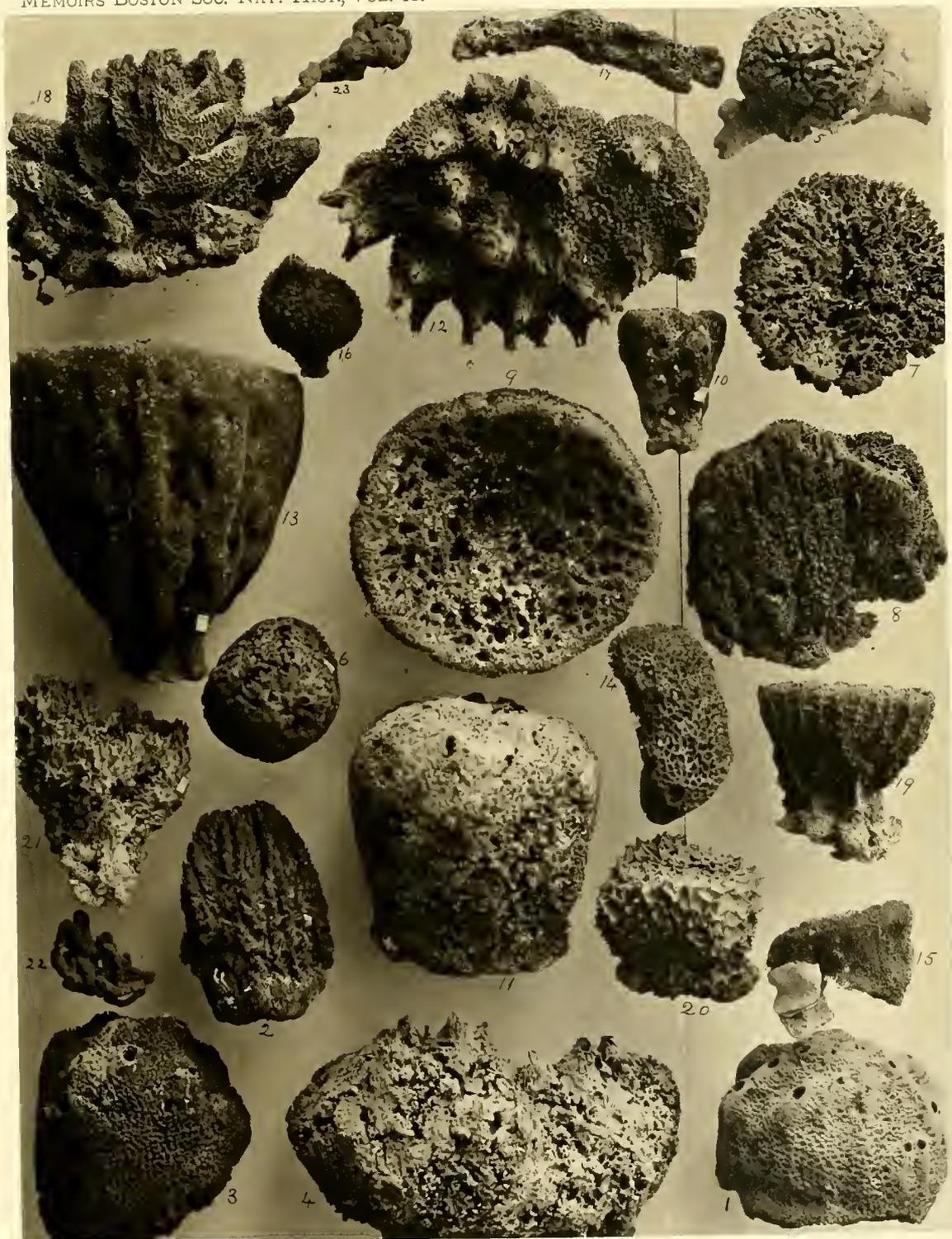
- Fig. 26. *H. acuta*. Fragment of a macerated skeleton. Loc., Nassau. p. 548.
 27. *H.* " var. *filamenta*. Loc., Cape Florida. p. 548.
 28. *H. campana*, var. *fixa*. Loc., Cape Florida. p. 546.
 29. *H. cartilagina*, var. *horrida*. Loc., Cape Florida. p. 549.

CERATELLA.

- Fig. 30. *C. labyrinthica*. Loc., Cape of Good Hope. Ward's Coll. p. 551.

PHYLLOSPONGIA.

- Fig. 31. *P. papyracea*. Loc., Cape of Good Hope. Ward's Coll. p. 543.



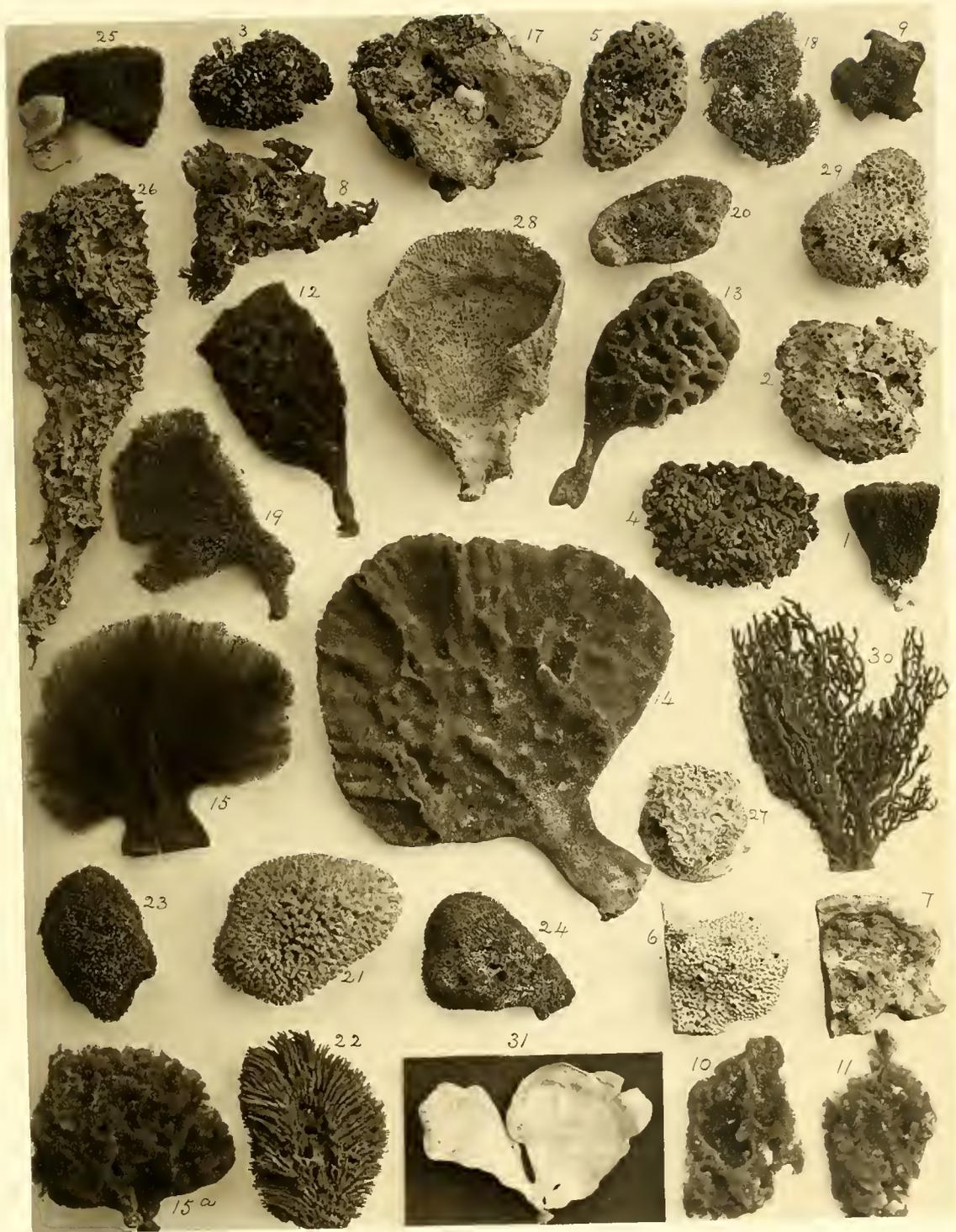
ALLEN & ROWELL, ARCON PHOTO.

A. HYATT, ON THE SUB-ORDER SPONGINÆ.



ALLEN & ROWELL, CARBON PHOTO.

A. HYATT, ON THE SUB-ORDER SPONGINÆ.



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