NATURE STUDIES

BY

C. J. Maynard

No. II

Province II

SPONGES

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PROVINCE II

SPONGES

PORIFERAE

"Here about the beach I wander'd,
Nourishing a youth sublime
With the fairy tales of science,
And the long results of Time."

TENNYSON

WEST NEWTON
C. J. MAYNARD
1898

SPONGES

DEDICATED

TO THOSE WHO WOULD

LEARN

BY

ONE WHO IS NOW AND MUST EVER

REMAIN A PUPIL IN

NATURE'S VAST AND UNENDING

SCHOOL.

"And he wandered away and away
With Nature, the dear old nurse,
Who sang to him night and day
The rhymes of the universe.

And whenever the way seemed long,
Or his heart began to fail
She would sing a more wonderful song,
Or tell a more marvellous tale."

LONGFELLOW.

PREFACE.

The Arabs have a proverb which declares, "That men are four; — first, he that knows not and knows not that he knows not; he is a fool, shun him; second, he that knows not and knows that he knows not; he would learn, teach him; third, he who knows and knows not that he knows; he is asleep, awake him; fourth, he who knows and knows that he knows; he is wise, follow him."

According to this proverb, the truth of which none can gainsay, the acme of wisdom lies not only in having knowledge, but in being absolutely certain of that knowledge, which certainly can only be acquired by actual personal investigation of a given subject.

It is the object of this little book to show teachers and others interested in the subject of which it treats, how to see for themselves, by showing them what to look for, and I shall try and not ask my readers to look for anything which I have not myself seen.

There are many books written upon Zoology, but few, however, are by original observers. It has long been a certainty with me, that the more teachers put themselves in direct communication with original observers, the more they will learn, and the better fitted they will be to teach.

I have long been interested in sponges, and began to pay attention to them in 1870, when on a visit to Key West, and have studied them constantly ever since, whenever opportunity offered, both in Florida and in the Bahamas, and other West Indian Islands.

The results of these studies are being published in my Contributions to Science, beginning with Vol. II, and continued through other volumes, but I have here given much of this matter in a condensed form.

Other numbers of this series containing accounts of the Corals, and Gorgonias, Echinoderms and Starfishes, Mollusks, Insects and Vertebrates will follow as rapidly as it is possible to publish them.

C. J. M.

West Newton, Mass.

January, 1898.

INTRODUCTORY.

Sponges, which we now so clearly know as animals, were not many years ago regarded by most of our prominent naturalists, as belonging to the vegetable kingdom. Thus Owen, in the last edition of his work on the Anatomy of Invertebrates, published in 1855, omits sponges, thereby giving us to understand that they were quite beyond the pale which bounded the kingdom that he had under consideration. In fact, he alludes to them several times in his book, as forms of vegetable life which produce free swimming spoors, as seen in some of the sea weeds.

Even after the sponges had been fairly introduced into the system of the Zoologist, they received comparatively little attention. In fact there is scarcely any group of animals which are so widely distributed, and which are represented by so many species as the sponges, which have been studied so little by naturalists. What is true of sponges in general, is true of the sponges of North America, especially of the West Indian and Florida waters.

Until 1864, our knowledge of sponges of the West Indies and Florida was confined to rather unsatisfactory descriptions of a few scattering species, by Lamarcke, Lamoroux, Schmidt, and a few others; then appeared the "Spongiairie de la Mer Caraibe" by Duchaissing and Michellotti. So unworked was the field examined by these authors, that out of about one hundred and twenty forms described by them, something like one hundred were actually new to science. In my studies of West Indian Sponges, I have been greatly aided in the identification of species by the description and figures published in this work, all of which I have found amply sufficient to enable me to decide unhesitatingly as to the identity of any species with which I am familiar, that they have described. I am aware that my experience with this work is somewhat at variance with the expressed opinions of some other authors, but it must be borne in mind that Duchaissing and Michellotti had the advantage of studying sponges in their native element, and that both their descriptions and figures are made, in most cases, from living or fresh specimens, and that I, having had a similar experience, can more readily comprehend their meaning, than others who have never procured living specimens. By these remarks I do not wish to be understood to say that I fully endorse the systematic arrangement of these authors, or that I consider all the forms described by them as species, as entitled to specific rank, but I do mean to say that I consider that, under the circumstances, they have written a most excellent work, and one well worthy of the careful attention of students in this department of animal life.

Following this work, we find a few more scattering descriptions of West Indian Sponges, mainly by Messrs. Bowerbank and Carter, until in 1875, the first part of Prof. Hyatt's careful "Revision of the North American Poriferae" appeared, followed the next year by the second part.

Although most lamentably Prof. Hyatt's work has never extended beyond the horny sponges, considering the material he had in hand, he has done his work very thoroughly, insomuch so that there are few forms which he did not recognize in some way, that I have found in the West Indies and Florida. He described several new species, most of which I can endorse; his errors are in the main due to conservatism, (a safe side as a rule, with a scientist if indulged in with moderation,) and to the fact that he was unfamiliar with the living sponges.

PROVINCE II. SPONGES. (PORIFERAE)

Animals of a vegetable-like appearance, fixed when adult, free when very young. They are generally composed of two substances; a hard, frequently horny inner skeleton, and a softer outer covering, which is composed mainly of a protoplasmic substance, which somewhat resembles flesh, and which is known as rudimentary flesh or sarcode. Spicules, composed either of lime or of silica, are often embedded in this flesh. See remarks under groups of sponges.

This flesh and skeleton is permeated by numerous tubes which are of three kinds, each of which has separate functions, but all of which form a water system. One set, smaller than the others, and which open externally, are incurrent tubes. Through these, the water is taken into the interior of the sponge, where it is taken up by the second set continuous with these and conveyed to third largest set, the excurrent, which reach the outside, and from these the water is thrown out.

The water circulates freely through these tubes which answer for a respiratory system, and for the conveyance of food to the interior of the sponge.

The water is induced to flow into the incurrent tubes by the motion of cilia, which are really false feet or pseudopoda, not unlike those seen in the Amoeba and other Infusoria. See Fig. 5, where I have given a cut of an ideal section of a cilia cell of a sponge. B is the incurrent tube; A the cilia, all with the cilia-like pseudopoda. Compare this with those of the Amoeba, Fig. 4, the projections being the psuedopoda. The water system, form of the cilia, etc. is more fully explained further on.

For difference between sponges and other closely allied animal organisms, see general conclusion at the end of the book.

GROUPS OF SPONGES.

Sponges may be divided quite well into two groups, namely, Horny and Spiculigenous species; but it must be understood that, although in the majority of species it is quite easy to decide to which group any given sponge belongs, there are species, the position of which is not so easy to determine, for they are so unequally made up of spicules and horny matter, that they occupy a position directly between the two groups, and form, in a measure, connecting links between them; that is, some contain very few spicules, others more.

HORNY SPONGES.

As the sponges comprising this group are the most important, we will first consider them, and a description of their general structure will answer for that of nearly all sponges.

Let it first be understood that which is known as the sponge of commerce, is simply the skeleton of the living sponge. A sponge when living is so different from this skeleton, that it is quite difficult for an expert to recognize a living sponge, when he sees it for the first time, even though he may have been perfectly familiar with the dried specimen or skeleton.

When living, sponges are covered with what is known as sarcode or sponge flesh, a flesh, however, which when compared with that of other animals, is in an exceedingly rudimentary condition. This flesh not only covers the outer portion of the sponge, but also lines all of the internal orifices. It is of different degrees of firmness, but is usually quite soft, and is covered, where exposed, with a kind of skin which is of a somewhat denser structure than the flesh that lies within it. There are, in fact, especially in young sponges, three layers: outer, (ectoderm); middle, (mesoderm); inner, (entoderm. Both skin and flesh are often quite brightly colored, some species being brilliant orange, yellow or scarlet, but many species are black or brown externally. Those which are brightly colored change their hues quite quickly upon being removed from the water, and usually become black, a color which the majority of species assume when dried with the flesh on the skeleton.

Upon examining a living sponge, it will be found that there are two kinds of orifices; first, a large number of small ones which are quite uniform in size. These are the incurrent orifices, through which the water is taken into the interior of the sponge. Second, we find a smaller number of larger orifices which are rather irregular in size, some being much larger than others. These are the excurrent orifices, from which the water passes out of the sponge after it has circulated through the interior.

Some sponges are tubular in form, with a few excurrent orifices, sometimes with one only. Such sponges are rather more simple in structure, and their organism can be much more readily understood by a beginner than if a sponge of more complicated structure is taken. Such a species may be found in the Tube Sponge, of the genus Verongia which I will take as an example in explaining what is known as the water system.

The Tube Sponges are large, prominent sponges, with the form cylindrical and tubular for their entire length. See plates I and II. Tube, occupying more than one half the diameter of the sponge, hence the walls are only moderately thick. Outer surface roughened by circular projections, that extend outward about one half the thickness of the walls.

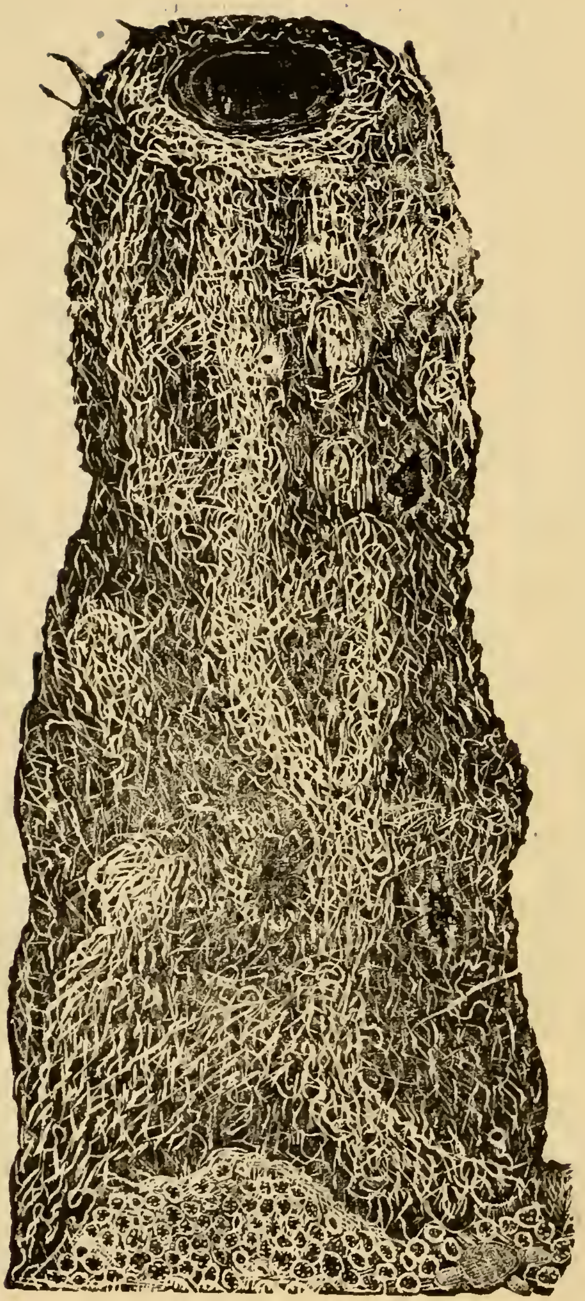
STRUCTURE. In life this species is fleshy, yet is soft and compressible, but when dried with the sarcode on, it is very rigid. The water system is comparatively simple. On the outer surface of the sponge, are small tubercules about .05 in diameter (all measurements are in inches and in hundredths of inches) by about .01 high. In the center of each of these tubercules is an opening, some .02 in diameter. This opens into a cylindrical tube some .10 long The walls of this tube are composed of rather tougher material than the lining membrane of the water system, and may not only be removed entire, but also often remains intact after the sarcode has been marcerated away. (See Fig. 2. A, B, where I have given an enlarged cut of this tube : c, is its opening.) As seen, this orifice is not guarded by any sphincter, or other membrane or valve. In fact, the rigidity of the walls show that the mouth of the tube is constantly open.

The incurrent tubes open into cells which vary in diameter, from .10 to .25. Usually the upper cell is a little longer than wide, and opens into another similar cell, deeper in the walls of the sponge, and this into another, and so on through a series of from four to seven, or even more, the last resting against the lining membrane of the central tube. (See Fig. 2 a, a, a, a, being the incurrent tubes with the cells below them.) Sometimes the opening between the cells is partly closed by a kind of translucent tympaniform membrane. that is stretched from one twig of the skeleton to another. (See Fig. 2, B. v. v, v, where I have given a cut of these tympaniform membranes enlarged about three diameters, and as will be seen the form varies.)

From the sides of many of these cells, open small tubes which communicate, often in a winding manner, either with some other similar tube, or with another system of cells, but without any regularity. (See Fig. 2, where I have given two of these tubes, connecting two cell systems, and the black dots in the cells show the entrance to other tubes, and others may be seen at A, T. T, and O, O, in B.

The surface of the membrane lining the great central tube of the sponge is smooth, and scattered very irregularly over it are openings, which are not situated upon tubecules, and which are provided with a kind of sphincter mus-

Fig. 1.



Tube Sponge, Verongia fistularis, Allen's Harbor, May, 1893.

cle, by which the opening is closed, in fact, the opening appears to remain closed, unless opened by pressure of fluid from within. These are excurrent openings, and they communicate through a short cylindrical tube, having soft walls, often directly in contact with the last cell of the water system. (See Fig. 3, D, and also c in Fig. 2, A and B.

The incurrent orifices are about .25 apart, on the average, and are scattered quite irregularly over the surface, varying in number from 12 to 16 to the square inch, (See Fig. 9 where I have given the actual number to a square inch of the surface of a cylinder, which was about eight inches long, showing

Fig. 2.

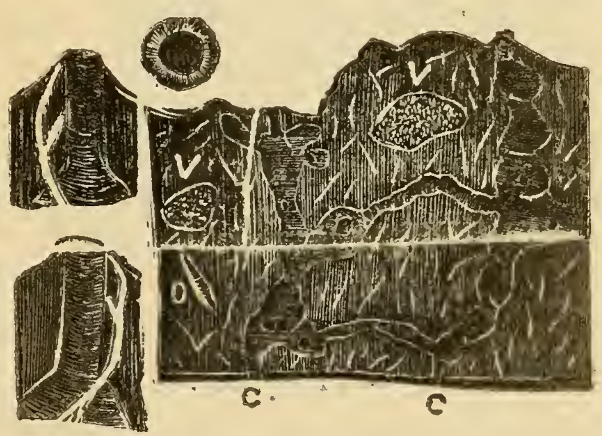
a a a a

c c

A B

Fig. 3.

F E a



C D

Water system of Tube Sponge considerably enlarged. Allen's Harbor, May, 1893.

the true position of the incurrent openings, and their number, but considerably enlarged.

On the other hand, the excurrent openings are not numerous and are seldom or never found near the mouth of the great central tube. Thus it will be seen that, from necessity, one system of cells, which has no direct communication with any excurrent opening, must empty its contents into another system that does, and this is frequently the case. There is another method, however, which I have found near the termination of a cylinder, that was eight inches long. Here one excurrent tube opened into a long, tubular cell, that, extending upward, received the contents of no less than six cell systems, each successive one growing shorter, as the sponge grew thinner toward its termination. All of these cell systems opened in a line on the inside, but became diffused somewhat externally to meet their respective incurrent tubes. This should be kept in mind in consulting the diagram at Fig. 5, where this system is given at A.

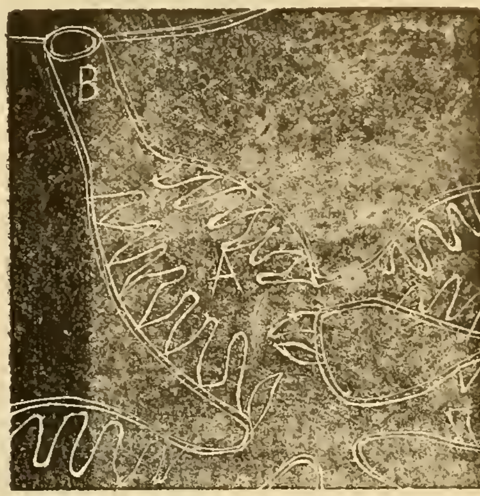
L shows a side view of the elongated chamber, lying just within the skin of the central tube, with the six cell systems opening into it, and below it is a top view of the same, all of the circular dots being the position of the incurrent communication with the cell, excepting c, which is the excurrent opening in both top and side views. Another method of the concentration of the incurrent tubes may be seen at Fig. 2, A, where the incurrent tubes, a, a, a, open into a common water system, L, which is quite wide. The actual number and position of the excurrent openings in one half of the central tube of a small size sponge may be seen at Fig. 6, near the bottom of the tube, O. There were eight of them (represented in the figure by the dots) in this half, and about the same number in the other half, and none at all near the mouth of the tube, and this is quite usual in this species of Verongia.

The method of formation of the water system is difficult to make out, but a smaller tubular system appears to penetrate through the sarcode at the extreme end of the cylinder, among the growing fibers of the skeleton, then the tough incurrent tubes appear to be formed in the skin of the sponge, outside the lining membrane and closing membrane of the mouth of the central tube, and then penetrates to the nearest newly-formed small tube, that connects with the older water system. Then the small tubes become gradually enlarged into the regular cellular system.

Fig. 4.

Amoeba.

Fig. 5



Ideal Cilia cell of Sponge.

The smooth lining membrane of the central tube is about .10 in thickness, and near the terminal end of the tube, it is projected forward to form the circular closing membrane, which, at the point of jointure with the regular lining membrane from which it arises, is considerably thickened, but becomes thinner on the inner edge. See Fig, 6 and 7 above o, both figures being life size.

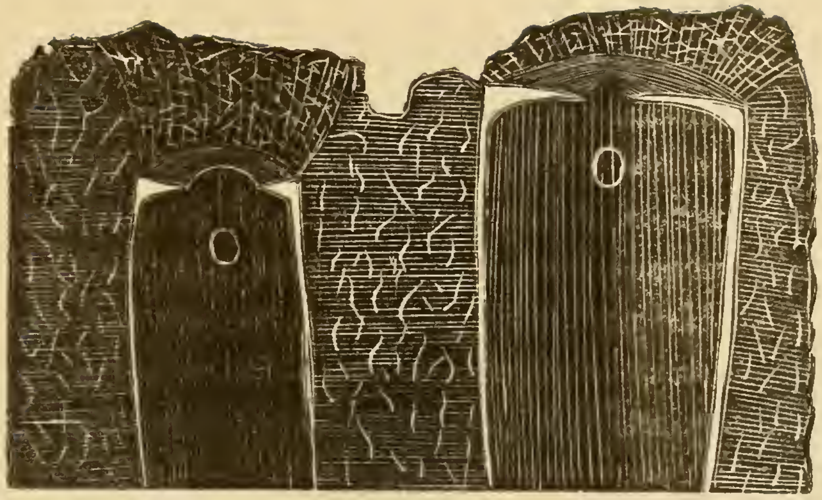
The cells into which the incurrent tubes open, are provided with cilia or vibratory organs which are quite likely thrust out from the flesh forming the walls of the cell, much as are the pseudopoda, or false feet, of the amoeba.

These cilia perform a three fold function; they move in two directions, forward and back, thus by their movements, they cause an indraught of water: as this water, charged with air, bathes them, they gather air from it, and thus

Fig. 6.

Section of a small Tube Sponge, life size, which grew from a larger cylinder, a portion of which is given at o, o. Allen's Harbor, May 1893.

Fig. 7.

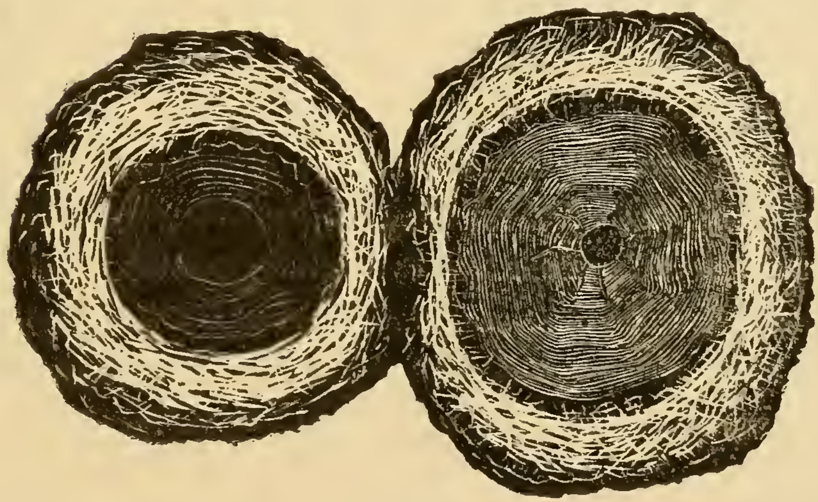


a a a a

A B

Section of Tube Sponge. O, tube above which is the closing membrane. Allen's Harbor, May, 1893.

Fig. 8.



End of the same sponge given in Fig. 7, showing closing membrane and its orifice.

oxidize the flesh, they also gather food from the water which they press against the walls of the cell into which it is absorbed, while the vitiated and depleted water flows on and out into the large excurrent tube, while the sphincter muscle, which guards the entrance of the small tubes, prevents its return into them.

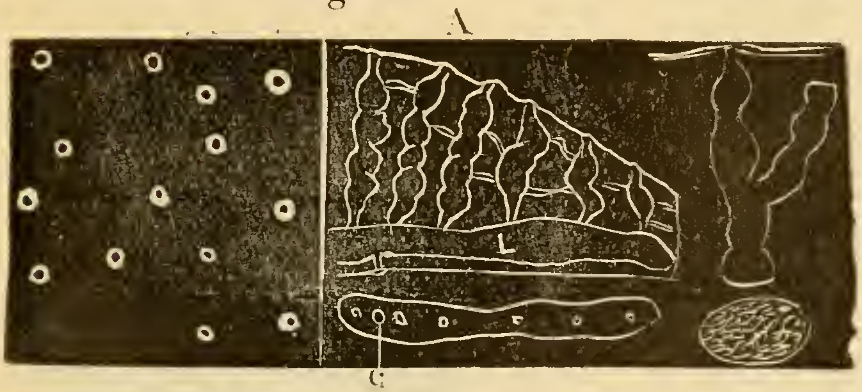
Sponges propagate in two ways, by ovules and by buds. In winter, ovules are formed in sponges, which in spring are thrown out of the excurrent openings. These may be quite easily seen in some of our fresh water species. These give rise to small, ciliated animals which swim about freely at first, but which soon become attached, and from them arise sponges.

Budding may be illustrated by my studies of the Tube Sponge. There it takes place, normally, at or near the base of some cylinder. The origin of a bud is first indicated by the thickening of the skin of the sarcode on the surface at some particular point, usually in some depression. The thickening of this appears to check the growth of the sarcode in that direction, as far as the thickened skin extends, and consequently the growth of the accompanying skeleton, but there is still an outward growth around the area formed by the thickened deposit. Thus a tube is begun, which at first grows wider (see Fig. 13, B, o, where a life-sized sponge is given), but after assuming the length of three inches or more, continues about the same diameter (see Figs. 6, 7, and 11). Often, however, especially should sand gather in the bottom of the tube, an extra membrane or skin is thrown across the tube, accompanied by sarcode, and followed by the production of horny fiber, and the narrow, basal portion of the tube is cut off, thus it becomes about the same diameter for its entire length.

The buds sometime form directly from the body of a cylinder or at some distance from it through the spreading out of a comparatively thin portion of the sponge over any material upon which it grows.

In the Tube Sponge eccentric budding occasionally takes place, that is, the buds sometimes have their origin above the base, but in such instances, we

Fig. 9.



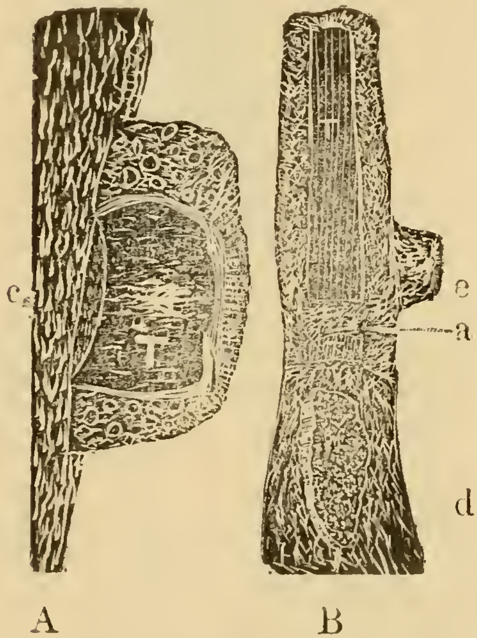
Water system of Tube Sponge. Allen's Harbor. May, 1893. Enlarged.

Fig. 10.

Skeleton of Aplysina gigantea, Bahamas, 1893, life size.

find that the large central tube (see Fig. 7, o, o,) has been stopped up or partly filled with sand or some other material, or the walls have become broken through, hence the base of the sponge has practicably been changed to a higher level. Such accidents, however, are comparatively rare, and thus any variation from actual budding at the base, either on or near a cylinder is rare. One of what is the most extreme departures from this rule occurs on a single cylinder seven inches high, the bud appearing about half way up the side. Upon examination I find that the sponge has been injured, two holes having been broken into its side near the base, admitting sand, with which the tube has been completely filled. A section shows that a partition has been formed above the sand; thus the bud has originated at what is really the base of the cylinder. (See Fig 11, B shows the cylinder, with the hole at d, filled with sand: T, is the tube; a, the partition; c, the bud.) On account of this abnormal growth, the tube of the cylinder is slightly

Fig. 11.



Illustrating abnormal budding of Tube Sponge: A, bud, life size; c, walls of parent tube: B, parent tube, reduced size; e, bud: a, partition; d, broken area: T, tube in both.

Fig. 12.

A, normal filament of Filamentous Sponge: B, unusual filament of Tube Sponge.

contracted at its termination. The bud is given at A, life size, and the relation of its tube, T, with the walls of the parent cylinder, c, may be seen. This bud had the closing membrane quite well developed.

Another case of eccentric budding is in a sponge nine inches high, where a bud had originated some two inches from the base ; but upon making a longitudinal section of this specimen, I found that the central tube of the large cylinder was abnormally narrow for two inches of its basal length, being only about a half inch wide, and the origin of the bud is just above this narrow portion.

In a sponge having two cylinders, one seven and the other four inches high, two buds have appeared between the cylinders, one above the other, the highest being 2.50 from the base, and the other is directly beneath it ; but both those buds adhere to the largest cylinder, and I find by measuring the depth of its tubes that the lower bud is really basal. Furthermore, the walls of the sponge are abnormally thickened, at the part where the buds appear, and as both the buds are of the same size, they probably originated about the same time if not simultaneously, and their appearance was probably induced by the abnormal thickness of the walls at this point.

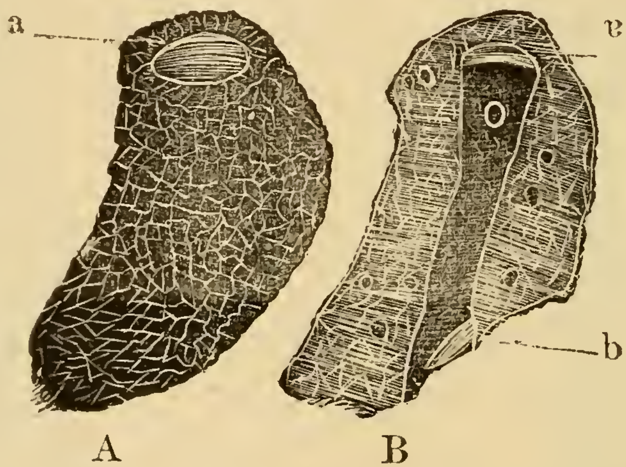
In another case in a group of three cylinders where the buds have appeared above the base, I find that the Verongia has been attacked by a parasitical sponge of the genus Funiculea. Another specimen, also having three cylinders, which has been attacked by a parasitical sponge, belonging to the Spiculiginous group, has several oscules formed, but they are very shallow, and are quite similar to those found in the branching species of the genus Verongia.

In another sponge which was of an unknown length, of which I have a section about a foot long, in which two or three tubes have become twisted and distorted by the clinging of a parasitical sponge, buds and branches have appeared in several places, not at all near the base.

Many species of sponges have the orifice of the excurrent tubes partly closed by a circular membrane which projects out like a collar from the margin.

This membrane is quite prominent in the Tube Sponge. In this species the closing membrane at the termination of the central tube is somewhat variable in its position. It is usually quite near the extremity of the tube, not as a rule over .10 from its termination. In one double sponge, however, I find that while in one cylinder it is in its natural condition, in its closely adhering neighbor it is at least .40 from the top. (See Fig. 7, where I have given a life-sized section of these tubes : that at B has the membrane in its normal position, while that at A has it much lower.) The width of the membrane varies greatly ; sometimes there is a mere trace of it, but it is usually moderately well developed. The largest membrane which I have ever found in an uninjured

Fig. 13.



Young Tube Sponge, life size. A, whole sponge ; B, section ; a, terminal closing membrane : b, extra closing membrane in broken portion.

sponge, in comparison with its diameter, was in a specimen where it extended entirely across the orifice, excepting a narrow opening in the middle, measuring .05 in diameter. The tube on which this membrane grew was .65 in diameter, and the membrane was situated about .25 from the termination. The next largest membrane was in the tube of the sponge (given in section in Fig. 7, B ;) a life-sized figure of this membrane is given in Fig, 8, B, and it may be contrasted with the more sunken membrane of its somewhat smaller neighbor at A. Just what the function of these membranes is, it is difficult to say, unless it is to prevent the accumulation of sand and other debris, in the central tubes. As confirming this hypothesis, it may be remarked that the central tubes of all the Verongia that I have examined, are remarkably free of foreign material of any kind.

When a cylinder becomes broken off anywhere, a membrane forms at its broken termination, but it is questionable whether the sponge ever increases in length again. (See remarks on this under Variation of the Skeleton.)

In one specimen which has been attacked by a parasitical sponge, and its structure greatly disturbed thereby, a partition has grown up within the main tube, near the termination, supported by the horny skeleton. thus forming a kind of double tube, each division of which is provided with its own membrane. On the side of the cylinder not far from its termination are two oscules, each with a membrane that stretches nearly across it, while other oscules are forming about it. This seems to me a clear case of reversion toward some ancestral branching form, brought about by the disturbance produced by the parasitical intruder; but to this subject I shall refer again.

An extraordinary case of membrane formation may be seen in the young sponge given in Fig. 13, where the terminal end is completely closed by a membrane (see ib., A, a,) and the lower or basal extremity being broken, exposing the inner tube, a membrane is partly formed across the exposed portion, which as the normal opening was closed, became the mouth. (See ib. B, b, being the supplementary closing membrane.)

In two or three other instances where I have seen holes broken in a cylinder, I have also found a membrane stretched partly across the tube above the injured portion. Unquestionably in this case, and also in the case of the young sponge cited above, an attempt has been made to repair the injury to the cylinder. This injury could not be remedied by a new growth from the broken portion, for as I have demonstrated under the head of Skeleton, no growth of either sarcode or of horny matter ever takes place from a broken surface. Hence it is that the membrane is first thrown across above the injured portion as a preliminary to the growth of the sarcode and accompanying skeleton, thus accomplishing a permanent repair of damages. The specimen in Fig. 11, B. shows an example of where a permanent partition has been formed above a broken cylinder. In this case the cavity, d, has been filled with sand and the partition a, has been formed above it, completely across the tube. So solidly was this partition constructed, that it formed a new base for the sponge and, as seen, a bud grew from above it.

I have found one other remarkable variation in the formation of this membrane in a tube, where, by some accident, the whole sponge was pressed flat when living, probably temporarily closing the terminal orifice of the central tube. Then there was a new orifice formed on one side; but the pressure afterwards being removed, and the original terminal orifice reopening, that in the side was closed by a membrane.

Sometimes, more especially in large single cylinders, the tendency to grow outward at the extremity is so great that the tube gradually widens, and becomes trumpet-shaped. Such cylinders are inclined to bend downward, and I have found quite a number of these specimens among the sponges gathered at Inagua. These sponges being simple cylinders, with thin walls, have evidently thrown all of their vigor into an upward growth, but all stages of intergrades occur between this form and the types.

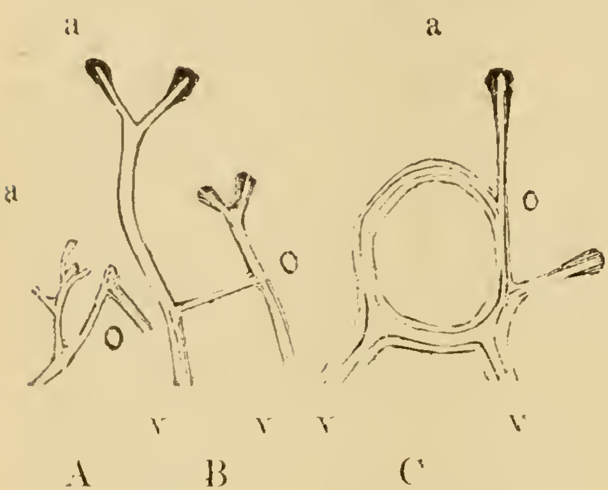
SKELETON.

The skeleton of the group of sponges which we have under consideration, is composed of horny matter, which increases in thickness with the age of the sponge, hence older sponges are of a firmer structure than when young. In the Tube Sponge, in which the fiber of the skeleton is quite large, we find one of the best species for study.

The general color of the skeleton is amber, light when young, but darkening with age. The fibers are cylindrical, well rounded and seldom flattened even at the points of the jointure. They are hollow and at the extreme tips of the new growths are composed of a single, soft membrane which is yellow in color and opaque. This soon becomes covered with a layer of pale, amber-colored, horn-like matter which is nearly transparent, and successive layers of this horny matter are deposited ; thus the older growths not only become larger in diameter, but darker in color on account of the continuous thickening of the deposits. (See Figs. 14 and 16 where I have given an enlarged cut of the fiber, a, being the new in A, C and B in Fig. 14, and y the old ; then compare with the old growth in Fig. 14 C , in this the original hollow membrane may be seen through the transparent walls.

New twigs of the fiber arise from division at the extreme tips of the new growths. (See Fig. 16 C, a, and Fig. 14 a.) The twigs thus formed, although of an equal length at first, do not always remain so, for the onward growth of one may assume a different direction from that of the other, so that it may soon come in contact with the tip of another tube, forming a comparatively small mesh in the net-work of fiber, while the other may grow to a greater length, and then anastomosing, form a larger mesh, (see Fig. 14, K and S, where I give a life-size section of the growing skeleton of Tube Sponge, and the different sizes of the mesh of the net-work may be seen) consequently this forms an irregular anastomosis.

Fig. 14.



Illustrating the anastomosing and twig division of the fiber of Tube Sponge. B, a, division of twig. C, a, new twig before dividing. o, o, o, in all is the anastomosing point.

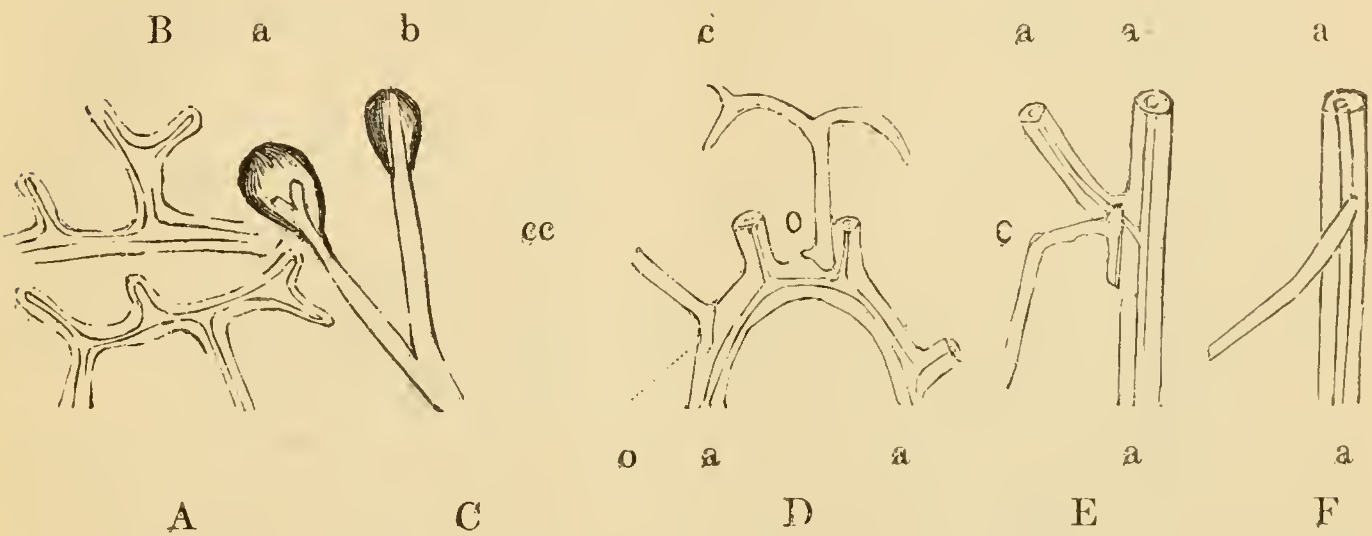
Fig. 15.

Illustrating arrested and abnormal growth of the fiber of Tube Sponge. C. arrested growth. A. B. abnormal growth.

As the direction assumed by a new twig is rarely the same as that taken by the one immediately behind it, sometimes the new twig comes in contact with the thick skin covering the outer surface of the sponge or with the lining membrane of the central tube ; in either case the hollow at the tip of the growing fiber becomes closed, and afterwards permanently sealed with horn. (For examples of these arrested growths, see Fig. 16, A and B, and Fig, 17, A to J.)

Thus it is easy to distinguish between what is a continuous, or new growth and an old, or arrested, growth. The growing twig, being much more slender

Fig. 16.



Fiber of the Orange Tube Sponge. A and B, arrested twigs from the inner tube. C, new growths. D, E, and F, new growth anastomosing against old ; a, old growth ; o, new.

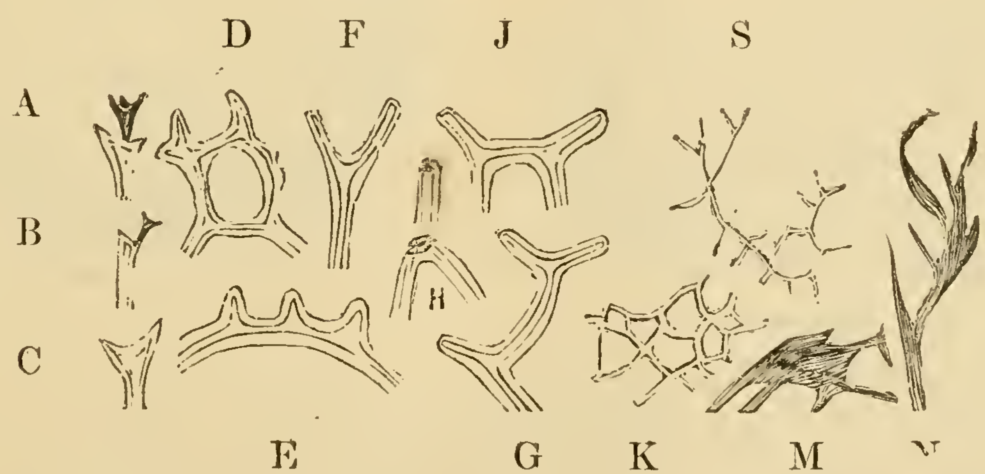
than the old growth, is destitute of horny matter at the extreme tip, and above all the termination in the new twig remains constantly open, while it is closed in the old growth. Thus by simply observing the condition of the termination of the twig, we can ascertain whether a sponge is growing in any particular direction or not.

Of course as the skeleton is formed from the sarcode, or sponge flesh, this always grows in advance of the horny fiber. This fleshy matter is rather more dense around new fiber, especially about the tips of the growing twigs. When division of the twig is about to take place, this thicker sarcode becomes more bulbose about the extreme tip of the growing twig than at other times, and in this bulb the division of the twig occurs. (See Fig. 16, C, a, where there is a divided twig, and compare with b, in which division is not taking place.)

I may here say, in passing, that the best way to examine the skeleton for a new growth is in an alcoholic specimen. The flesh may be easily removed, bit by bit, with a needle, taking care not to break the delicate terminal fibers. But although it is quite easy to satisfy one's self as to the method of growth, it is not always easy to find a twig in the act of dividing. I have, however, found several, and have a number of times traced a complete series from the very earliest division to the point of anastomosis or to arrested growths.

The growth at the terminal portion of the tube is most rapid, and of course upward and slightly outward, but never inward, and branches of the fiber continue to grow, sending out many twigs before any anastomosis takes place. Or in other words, that portion of the cylinder which is the most advanced, produces branching fibers which push upwards without anastomosis: fibers which send out lateral branches are the ones which anastomose. Anastomosis appears to take place by the tip of one growing twig coming in contact with the side of of another growing twig. This combination must take place near enough to the termination to have the inner membrane naked or not coverd even with a single layer of horny matter, then a perfect anastomosis takes place; that is. the tip of the anastomosing fiber absorbs that portion of the other's tubular membrane with which it comes in contact; thus the hollow becomes continuous from one fiber to another. The growth of the twig coming in contact is at once checked and horny matter is deposited over the place of jointure. (See Fig. 14 where I give three examples of the anastomosis of growing twigs at A, B, and C; o, being the point of jointure, and as will be seen this is not always at the same angle, that at B being at right angles, that at C being obliquely down-

Fig. 17.



Illustrating the skeleton of Tube Sponge. A, B, arrested twigs with secondary growths, C, twig arrested just after dividing. D, arrested twigs from external surface. F, G, J, same from surface of central tube. H, and above. the same with cuplike depressions. K and S, portion of skeleton enlarged four times. M and N, flattened fibers from the filamentous growth. E, arrested twig which came in contact with a hard surface.

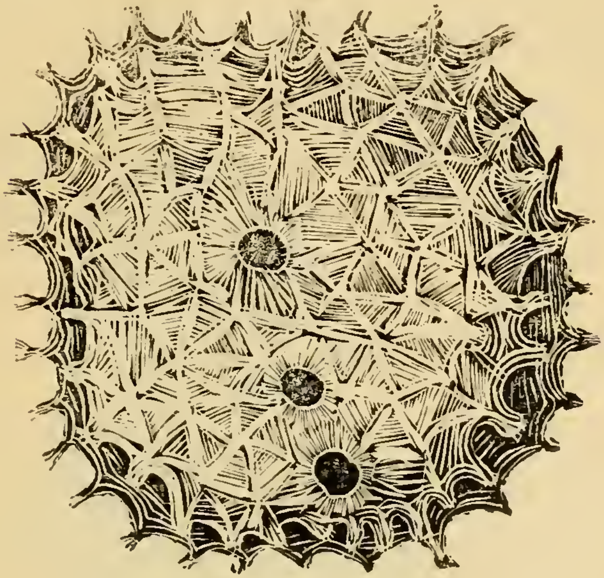
ward ; while at A it is evident that the tips of two twigs came directly in contact, and upon anastomosing the growth of both was checked.)

It is absolutely certain according to my most carefully made and often repeated observations that no buds ever start from the side of a twig or branch. Hence the interior of the skeleton of the Tube Sponge presents a very finished appearance, there being no protruding twigs or arrested growths which have not anastomosed. (See Fig. 17, K, where I have given a portion of the interior of the skeleton, life size. This is not, however, where the twigs have come in contact with the skin of the outer surface, or with the membrane lining the central tube, for here as I have previously remarked, we may find many short, protruding twigs.

As both sarcode and skeleton become arrested as soon as they become covered with the lining membrane of the central tube, it will at once be seen that there can be no increase of growth inward after this membrane is grown ; and that the form of the sponge is determined by it. The tendency of the growth of the sponge is thus upward, and although, somewhat singularly, the upward growth sometimes considerably precedes the thickened lining membrane (See Fig 7, A) the inclination of growth is very rarely, or never, inward. For proof of the assertion that the lining membrane arrests any inward growth, see Fig. 7. A and B. a, a, a, a, being the lining membrane of the tube, also in the young specimen, fig. 13, B, where the tendency of growth is outward so as to gradually form a wider tube.

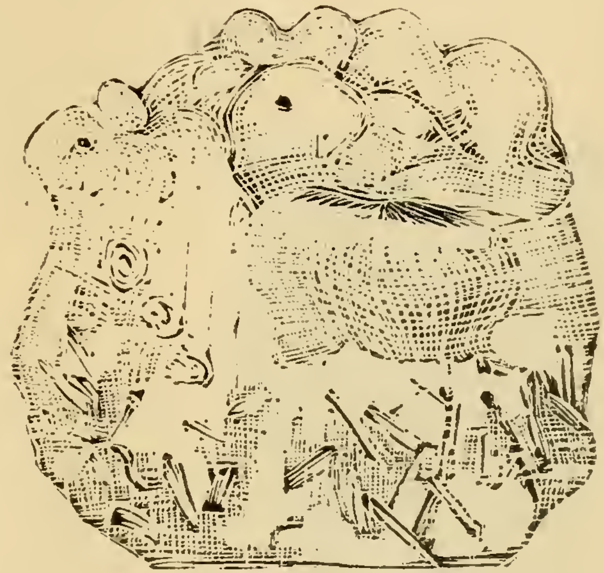
Returning again to arrested growths of the twigs of the skeleton, we find that those on the outer surface of the sponge, differ as a rule, from those on the inner. The differences are slight but very constant. Externally the growth appears to be checked gradually as it comes in contact with the outer skin, and as a consequence the arrested growths are pointed. (See Fig. 17, C and D: the two twigs in the latter named being normal, that at C having become arrested

Fig. 18.



Logger-head Sponge.

Fig. 19.



Scarlet Sponge.

on the external surface, and the sponge has become finished in that direction, a kind of secondary growth appears that is quite independent of the hollow structures of the fiber. These form minute, rather opaque, often branching twigs, having their origin directly on the end of the arrested growths. Examples of these may be seen in Fig. 17, A and B.

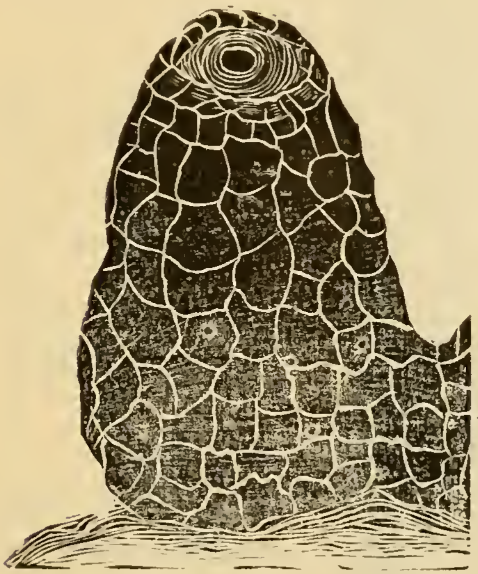
Internally, or against the lining membrane of the central tube, we find the growth much more suddenly arrested. Hence the twigs present a more truncated appearance. (See Fig. 17, F, G, and J, and Fig. 16, A and B). In some cases the arrested twigs of the interior present a cup-like depression at the extremity. (See Fig. 17, H, and the one directly above it.) In these twigs the hollow membrane is sealed, but is covered with only a thin layer of horny matter. This is evidently the consequence of the twig having passed a little beyond the sarcode into the lining membrane of the tube. Or rather this is the condition under which such twigs are found, but it is quite probable that the lining membrane has absorbed a portion of the sarcode and grown around the twigs before the usual quantity of horny matter was deposited on their extremities.

VARIATIONS IN SKELETON GROWTH.

I have said that new fibers usually anastomose with new growths, and this is true where an unbroken internal membrane occurs; thus this is the normal method of growth, but where new and growing fiber comes in contact with an old growth, a kind of anastomosis takes place. In this case the growing tip of the new twig comes in contact with the horny side of the old growth and is soldered there by an accumulation of additional horny matter, secreted quite likely by both the old and the new sarcode. But in all such anastomosis there is no connection between the internal hollow membrane of the fiber of one growth with that of another. That is, the new growth does not penetrate into the horny covering of the old growth as it does into the membrane of the new.

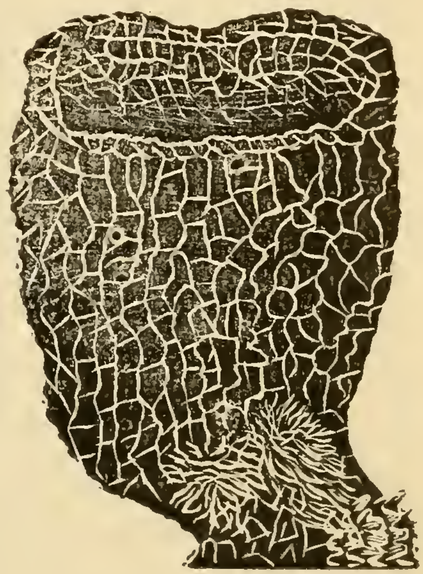
Another peculiar feature of this method of anastomosis is that when the new growth comes in contact with the old, the new twig, no matter at what angle it comes against the horny side of the old growth, usually continues to grow for a short distance, thus ensuring a greater surface of attachment. But as I have never succeeded in finding a case where this growth continued entirely beyond the point of jointure, it is probable that the horny matter, secreted by the sarcode upon both the old branch and the new twig, especially the former, soon closed the open tip of the new twig, thus preventing further growth.

Fig. 20.



Net Sponge.

Fig. 21.



Giant Cup Sponge.

In Fig. 16, at D, E, and F, I give four methods of this kind of anastomosis when new twigs have come in contact with the old (in all of these figures, a is the old growth and c the new) all at different angles. In that at D, c, c, the new growth came upon the old branch obliquely, grew slightly backward, but further forward, then became arrested. The new twig above this at c, came upon the old branch directly at right angles and passed partly around it. The twig at E after bending at o, reached the branch at a slightly oblique angle, and on account of another branch being in the way, after progressing forward a little way, its growth was forced abruptly backward. At F the twig has come in contact with the branch along its side not directly against it, as in other instances; yet even in this case it did not progress far. All of these examples of anastomosis occurred within a short distance of one another, but there were hundreds of similar cases in this same sponge.

Upon the most careful examination of this and other sponges of the species where a new growth has come in contact with an old one, I have failed to detect the slightest sign of any revivification of the old skeleton. This has led me to the conclusion that after the horny matter has been deposited over any portion of the fiber, no outward growth of buds nor twigs can take place. This conclusion is borne out by the fact, previously mentioned, that two old sponges coming in contact do not anastomose along their sides.

From this we may judge that when a sponge is torn away from its base, that no new growth of fiber can take place along the broken surface. I am more convinced of this upon further examination into the matter during the past winter. When in the Bahamas in 1893, I gathered some Logger-head Sponges from a bar in Nassau Harbor near Fort Montigue. Two of these, which were about a foot in diameter, I partly pulled up, but left a smaller portion of the base attached. When I came to examine these sponges three years later, I found that although new sponge flesh had formed over the broken por-

B, Branching Sponge. A, Cord Sponge.

tion beneath there had been no new fiber formed, but the sponges still remained attached by the small remaining portion of the base.

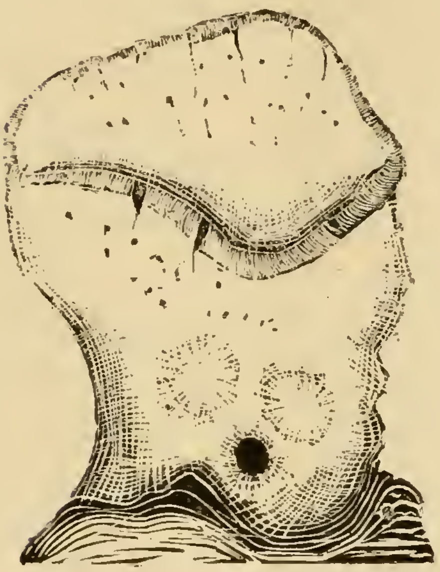
It is most evident that a new growth can take place only where the inner membrane of the fiber still remains in direct contact with the sarcode. It is also evident, as will be seen, that the membrane itself, is capable of producing new growths by division only at its extreme tip, and always before it has become covered with horny matter. After this horny material is deposited, the membrane appears to become dead. This I have proved conclusively by examining several tube sponges which have been broken, while living in the water, within an inch or two of the base. These bases were living, had deposited sarcode over the broken surface, (thus completly covering the ends of the severed portion of the fibers), and had in two or three cases even constructed new closing membranes at the entrance of the central tube, but upon carefully measuring one of these broken cylinders and examining others, I find that there is absolutely no new growth from the broken portion of the skeleton; nor are the tubes of the broken ends of the fibers even closed with horny matter. Of course, I have no means of judging when the sponges were broken, excepting from their appearance. These specimens were collected at Allen's Harbor, in about thirty feet of water, in a place that was quite well protected from heavy seas during ordinary weather. While it is of course possible that some large marine animal, like a shark or turtle, might have broken these sponges, it is more probable that they were injured during some hurricane. Now these sponges were collected in May, 1893, and the last hurricane before this that visited the Bahamas occurred in August, 1892, and this was not specially severe. If they were broken by the waves of that gale, they had eight months in which to repair damages, and they may have been broken during a previous season. Why the new sarcode deposited over the broken ends of the cylinder did not produce a new growth of fiber, independent of the old growth, as we have seen that it does when a new partition has formed across the central tube, and what the ultimate fate of these broken cylinders is, it is difficult to state. As I have never found any buds starting from their base, nor any larger growth about them, it is probable that these broken sponges being unable to entirely overcome the shock which they have sustained, are leading a kind of life in death existence, and that after lingering for a comparatively short time, die.

We have seen that abnormal conditions of growth appear to occur in the tube sponge when it is attacked by parasitical sponges. I cut off a portion of the specimen of which I have spoken on page 21 as having been attacked by a parasitical sponge of the spiculigenous group (the Purple Sponge, Pachychalina rubens), where the intruding species had come in contact with the skeleton, and upon examining it, found that many of the fibers are apparently in a diseased condition and present abnormal growths. They are enlarged in places by a whitish accumulation of a substance which appears to arise directly from the horny covering of the fiber and to form a part of it. Such examples are given in Fig. 15, A and B. There is also a great tendency to produce abortive twigs, often in terminal tufts.

We find this tendency to produce abortive twigs in the protuberances on the sides of aged and much roughened sponges. In these we also find a kind of secondary growth in the form of fine new twigs, which appear to be filling the cavities between the projections, thus thickening the walls of the sponges.

It now remains only to examine the fibers of the elongated filamentous growths of which I have spoken and of which I give a cut in Fig. 12, B, page 20. Here we find that the growth is inclined to be upward rather than lateral, that the meshes of the skeleton are elongated, and that the fibers are greatly

Fig. 23.



A

Fig. 24.

C B

A, Gray Cup; B, Green Cup; C. part of B, life size.

flattened. These fibers do not present a healthy appearance, nor are they thickly covered with horny matter. I give an example of these flattened and antler-like fibers in fig. 17, M and N. These are from the long filamentous projection of which I give a cut in fig 12, B. [Note, All of the figures of fibers given are enlarged about ten diameters excepting when they are given as being otherwise.]

It is instructive to note that when growing twigs come in contact with the rocky surface upon which the sponge grows, they become arrested suddenly in a similar manner as when they come in contact with the lining membrane of the central tube. (See Fig. 17, E, where I give a cut of three of these arrested growths.)

OTHER HORNY SPONGES.

Although the sponges given below are of no known commercial value, yet they are of great scientific importance, and a study of the type forms given will greatly aid the student in acquiring a knowledge of the sponges.

One of the most common Horny Sponges of the Bahama and Florida waters, is the Logger-head Sponge, one of the Goat Sponges (Genus Hircinea) all of which are characterized by their strong disagreeable odor, which bears a somewhat fanciful resemblance to the odor emitted by goats, but to my mind they smell strongly of phosphorous. (See remarks under the Odor of Horny Sponges.)

The color of sponges of this genus varies from greenish gray to gray and black. They live in comparatively shallow water, often on banks where they are exposed to the falling tide.

The skeleton is coarse, the fibers being flattened, and appear to be tied together in bundles which, when growing, project beyond the surface. (See Fig. 18, where I give the cut of a Logger-head Sponge, a typical species of a flattened spherical form, which often becomes two or three feet in diameter. Large specimens are attached so strongly to the bottom that they are torn away with great difficulty. This is a very common species.

Another abundant species of Goat Sponge is the Fringing Sponge, which grows in very shallow water and which is irregular in form, but which often extends along rocks and dead corals like a fringe.

Another horny sponge worthy of note is the Net Sponge, Fig. 20, which has an exceedingly coarse net-like skeleton, but which in life is covered with a dense sarcode which is about the consistency of liver, but which is of a greenish color.

Fig. 25.

Palm Sponge.

Fig. 26.

Branching Sponge.

Net Sponges occur in from four to twenty feet of water, and usually grow in irregular masses with mound-like openings, which are often partly closed by a membrane. (See Fig. 20, and also remarks on page 21 and following in regard to this membrane.)

A remarkable sponge which has a greatly enlarged tube, is the Giant

Cup Sponge. This grows in deep water, twenty feet or more below the surface. When growing this sponge is disk shaped, but gradually assumes a cup form. I have seen specimens eighteen inches high by a foot or more in diameter. The skeleton is coarse, with quite regular meshes. See Fig. 10, page 19, where I have given a life-sized cut of a portion of the skeleton of this species. Also see Fig. 21, where is given a cut of a Giant Cup Sponge much reduced. The color of this sponge in life is deep greenish.

Another form among the Horny Sponges, is the rather unique Cord Sponge, belonging to the genus Funicula. Here we find the sponge drawn out into long anastomosing branches. The fiber of this species is fine and the skeleton is not covered with much sarcode. In general appearance, the Cord Sponge reminds one of sections of the Branching Sponge (See Fig. 22, where the two sponges are contrasted) of our northern coast, but the Cord Sponge does not produce clustering branches as does the Branching Sponge.

In color the Cord Sponge is a beautiful purple lake. Another peculiarity about it is, that it is parasitical in habit, almost always growing upon other sponges. Other Horny Sponges will occasionally grow upon other sponges, but I have never seen any other species which were so habitually parasitical as this one.

ODOR OF HORNY SPONGES.

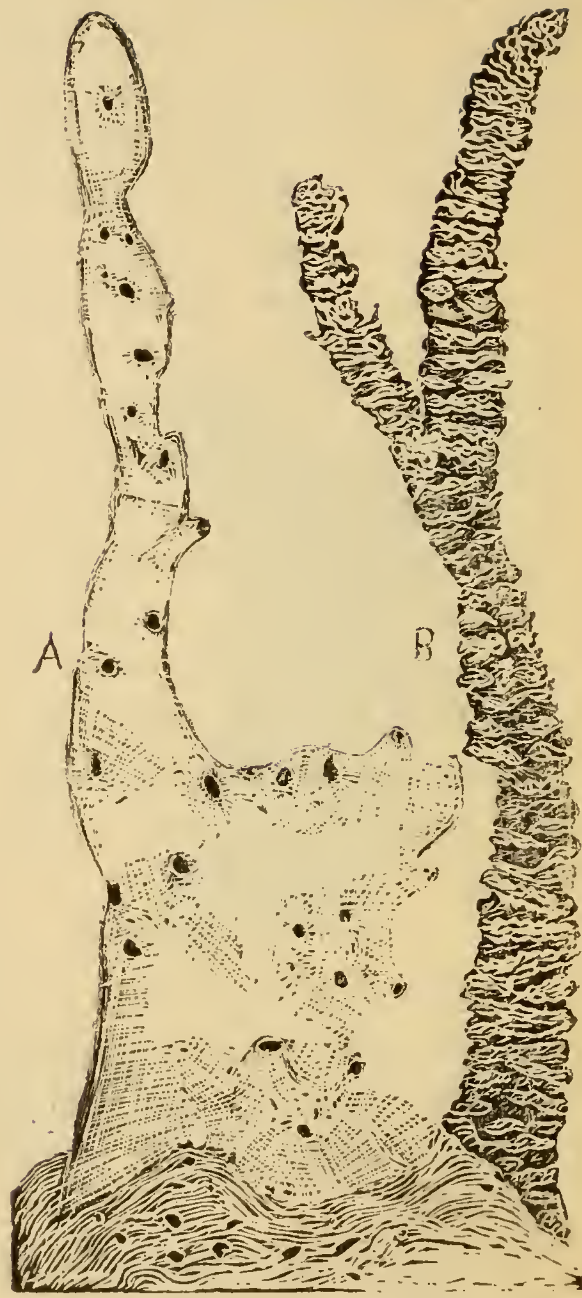
Most sponges have an exceedingly disagreeable odor when first removed from the water which they retain to some extent when dried with the flesh on. This odor appears to vary with different genera, insomuch so, that it is quite possible to distinguish to what genus any particular sponge belongs by the odor alone.

I have already alluded to the peculiarly strong odor of the members of the genus Hircinea or Goat Sponges. This is so intense in the case of the Logger-

Fig. 27.

Finger Sponge.

Fig. 28.



A, Purple Sponge: B. Red Sponge.

head Sponge as to become almost overpowering when one is handleing a freshly gathered specimen, and the peculiar phosphorous smell remains upon the hands for hours. So strong is this odor that it suggests that possibly the sponges which emit it may be of some commercial value on account of the phosphorus which must be continued within their tissues.

An exception to the rule that sponges emit a disagreeable odor, may be found in the Violet Sponge: a sponge, which although yellow in life, rapidly changes in drying to a bright violet. In this species the odor is not at all unpleasant.

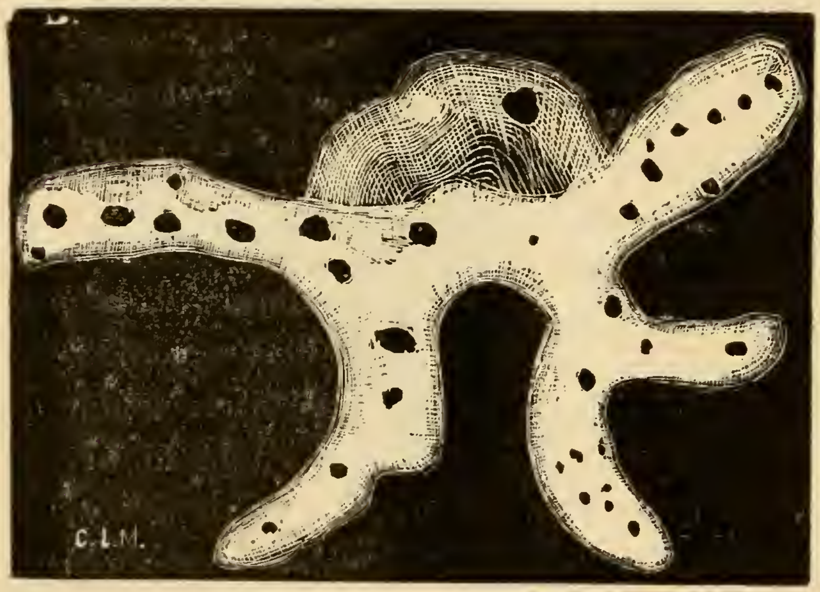
HABITS OF HORNY SPONGES.

Horny Sponges occur in all depths of water from between tide marks to forty or fifty feet deep. Among the commercial species, the Reef Sponge grows in the shallowest water, seldom being found at a greater depth than four feet, while I have often found them exposed by the falling tide. The best of the commercial species are found in about thirty feet of water. A few of the Horny Sponges grow upon mud or sand banks, but the majority of the species are found on rocky bars, here, in the great depths, below ordinary wave disturbance, amid corals and waving gorgonias, these singular organisms thrive best.

As a rule, sponges do not display any great sensitiveness upon being handled, but the Hollow-fibered Sponge, Dendrospongia crassa, shrinks very much upon being touched, completely closing the large excurrent tubes, that even if they were an inch in diameter before the animal was disturbed, become wholly indistinguishable in the mass of the sponge, nor will they open again for an hour or more. If a sponge of this species be cut away from the bottom, it appears never to recover from the shock, at least those which I have so removed and placed directly in pure sea waters never expanded, but died in a few days in a contracted state.

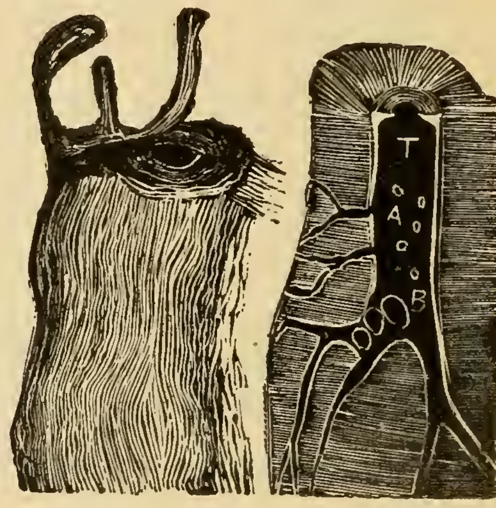
Most Horny Sponges grow firmly attached to a rock or other hard base, but an exception to this rule may be found in the Black Goat Sponge, a species which I have found growing on mud banks in Nassau Harbor, and on a bank east of the Current Settlement, Eleuthera. This species has the base

Fig. 29.



Creeping Sponge.

Fig. 30.



A B

Filamentous Sponge A, termination: B, section.

simply embedded in the sandy mud, from which it can be removed without any great effort.

Some sponges are very local in distribution. In this connection may be mentioned Maynard's Sponge (Stelospongos maynardi) described by Prof. A. Hyatt in 1876, from a single specimen which I obtained at Key West in 1870.

The type remained unique until I found a few at Inagua, Bahamas, in 1887. I did not meet with the species again until 1897, when I obtained a few on a beach on Pimlico Key, not far from Eleuthera, Bahamas. All thus far taken have been skeletons, the living sponge being unknown.

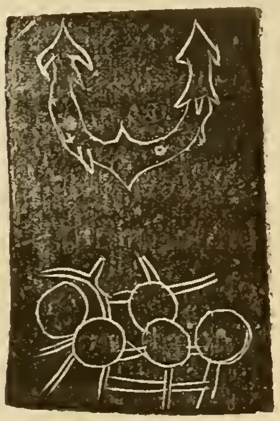
The Tube Sponge also presents a species which is very local in distribution. The first time I ever saw the Tube Sponge outside of a museum was on the Island of Inagua. Just to the north of Mathewstown are high cliffs which extend for about a mile along the water, terminating in a sandy beach to the northward. I visited this place in February, 1887, and during the preceding September a hurricane had swept over Inagua. The waves caused by this tempest had separated a vast number of sponges from the neighboring reef and lagoon. The sea must have been very high, for it had deposited thousands of sponges in one great wind-row on the top of the cliffs near the beach. Here I found hundreds of Tube Sponges, nearly all of them fully macerated. Few of them were absolutely perfect; being mainly detached tubes, but I learned considerable about this species and brought away two or three hundred selected specimens with me.

In all of my explorations among the Bahamas and Florida keys, I have found the tube sponge living in one section only, although I have constantly searched for it. When I visited Highburn Key in April 1893, I found the first specimens I ever saw growing on small detatched reefs in the little harbor to the south of the key. The reefs on which they grew were well out on the edge of the channel that divides Highburn Key from a neighboring key, and the sponges were in from twenty-five to thirty feet of water.

They were usually attached to dead coral and grew upright among hundreds of specimens of other sponges, but were always conspicuous when seen through the beautifully transparent water, on account of their brilliant orange yellow color. They usually prefer rocks slightly elevated above the bottom, but in some cases they grew directly on the bottom where they were surrounded by sand. When brought to the surface and exposed to the air they almost imediately begin to blacken, beginning to change color, first where they were bruised, even ever so slightly, then the dark hues spread rapidly over the entire sponge. When handled, the mucous-like substance which exuded from them also oxodized and stained the hands black.

Fig. 31.

A



B

A, spicules of Fresh Water Sponge; B, ova of same.

Fig. 32.

A, spicules of Salt Water Sponges: P, spicules of Fresh Water Sponges.

Upon the closest examination, I could not perceive the slightest shrinking nor any contraction of the sarcode, nor any changes whatever in the diameter of the orifice in the middle of the closing membrane of the central tube.

We also procured a quantity of these sponges at Allen's Harbor, about three miles north of Highburn Key, all growing in comparatively sheltered situations, as at Highburn Key: that is never directly in swift tide ways, but always in moderately strong currents, where they could receive a constant supply of fresh water.

When first taken from the water, the Orange Tube Sponges are quite firm, but as soon as they are dead they soften considerably, and in order to dry them in a natural form they must be laid perfectly flat and turned frequently. Unless the cylinders are very short they cannot be dried in an upright position, as they are liable to bend.

This species has a peculiarly sweetish odor, not as disagreeable as in many other sponges and this is retained in the dried specimens to a great degree ; this odor is particularly noticeable upon wetting a dried specimen. When thoroughly soaked, the dried sponge returns in a great measure to its former elacticity and becomes somewhat smooth, and then the incurrent orifices can usually be found.

Judging from my experience with this sponge, it is extremely local in distribution as it requires peculiar conditions for growth. The depth of water must be sufficient to protect the cylinders from any great wave agitation, for they break quite easily, as I have myself seen when gathering them with a sponge hook, and the large number of detached cylinders which I found on the cliff at Inagua also shows that they are easily broken off by any unusual disturbance of the water in which they live. It is evident that the zone inhabited by this sponge is in between twenty-five and thirty feet of water, and as this is not below the action of wave agitation during ordinary tempests, in order to exist unbroken, the Orange Tube Sponge must seek the protection of either land locked or reef locked harbors, in which the water is of the proper depth. and through which moderately flowing currents constantly sweep.

The Filamentous Sponge, a small species with long filaments, appears to be one of the most local in distribution of any of the members of the genus Verongia. I know of a single locality only where it occurs, and here it grows in a very restricted area. This is a sandy bar which extends from the eastern end of Hog Island into the channel which divides this little island from a neighboring key which lies to the eastward. That portion of this bar that is inhabited by these sponges is never exposed by the falling tide, so that the Verongias are always under water, although sometimes they come very near the surface.

The Filamentous Sponge is always attached to a rock or coral, but these bases were surrounded by sand on the bar where I found them. There were a few other species of sponges growing there, notably a dark purple species of Pandaros, a spiculigenous sponge, and a few others of this group, but although some of them were parasitic in habit, none grew on the Verongia, nor did I ever find Filamentous Sponge attached to other sponges.

This bar, or rather that portion of it on which this species grew, was about a hundred yards long by fifty yards wide, and even here the sponge was not very common. I found about twenty-five specimens, and these were all I ever saw anywhere, although, according to Duch. et Mich., the species occurs about St. Thomas.

They are beautiful objects when in their native element, especially the branching forms, as then the long yellow filaments wave gently in the flowing current, closely resembling the branches of some of the algae. When the sponge is living, the filaments have a tough, rubber-like consistency, and are then not easily broken; but when dried, they are exceedingly brittle. This former elasticity may be in a great measure restored to them, however, by placing the sponge in water.

Since the foregoing was written, I have found this species in other portions of Nassau Harbor, but never in abundance anywhere.

I have been often asked whether I think that a sponge is an individual or a colony of individuals. From the point of view presented by individuals, as we see and understand them, in the vertebrates, or even in the higher invertebrates, the whole matter of individuality in the low forms to which the sponge belongs, is difficult to understand, but we can say that a careful consideration of the foregoing array of facts will certainly lead us to the irresistable conclusion that, whether or not we regard each cilia cell, or a number of these cells, as constituting a separate individual, equivalent, for example, to a coral polyp, the water system and its accompanying cilia cells, at least combine together in emergencies, and with common sympathies and common energies act as the organisms of a single individual throughout the whole sponge.

COLOR OF HORNY SPONGES.

Although in this group the colors are not as brilliant as in the spiculigenous species, there are some among them which are quite brightly colored. Sponges belonging to the genus Verongia, of which the Tube Sponge is a member, are highly colored. Orange, bluish, and malachite green are among the colors with which these various species are ornamented. An example of the color of the Tube Sponge is given on Plate II, and on Plate I will be found an example of the same species when dried

All of the commercial species are glossy black externally when living, and dull black when dried with the flesh on. The interior of some of some of the species is dull orange or whitish. A black tar-like substance sometimes flows out of the excurrent orifices of some of the Horny Sponges which is probably the decaying flesh, and this has a very disagreeable odor.

The Reef Sponge when placed in formalin, changes the liquid bright red, and some other sponges change color when dying and give out colored fluids. The Violet Sponge, already mentioned, gives out a violet fluid, and the sponge changes from greenish yellow to this color.

The skeleton varies somewhat in color in different genera. Commercial sponges have the skeleton, when unbleached, rather pale amber, but it must be always kept in mind that the skeletons of young sponges are lighter in color than adults.

Sponges of the genus Verongia have the skeleton dark amber. The skeleton of the Goat Sponges is very light in color, often nearly white, and the same is true of the Net and Maynard Sponge, both of which belong to the genus Stelospongos.

GEOGRAPHICAL RANGE ETC. OF HORNY SPONGES.

Horny sponges do not occur north of Cape Hatteras and Bermuda in the west Atlantic. How far south they extend along the American coast has not been definitely ascertained, but probably to southern Brazil. On the eastern side of the Atlantic they have been found from England to the Cape of Good Hope. They also occur about Australia.

On the Pacific they occur from southern California to Chili. It will be seen from this range that Horny Sponges do not occur in very cold water and in fact, the species are most abundant in the tropical and sub-tropical waters.

No Horny Sponge has been found at a greater depth, than one hundred and fifty feet and this is much deeper water than in which the majority of the species thrive best. The proper ocean zone for Horny Sponges where the majority of species occur, is between three and forty feet, and as far as my observation extends, they always prefer localities which are fully exposed to the rays of the sun, and where they can receive the full benefit of the incoming tide.

GATHERING AND PREPARING COMMERCIAL SPONGES.

As the sponges of the Mediterranean are more valuable than those from our American waters, greater care is used in gathering them. They are taken by divers and dredges and considerable care is also used in their preparation for market. The following is an account of the method by which Florida and Bahama Sponges are gathered and prepared for the market as I have witnessed it many times.

Vessels are fitted out by merchants who own them, and let on shares to a crew which consists of from six to ten men. The vessel claims one third of the sponges taken, and the men share the rest equally. An outfit consists of a boat for every two men, two or three sponge hooks, with staves of varying lengths from ten to thirty feet, a water glass and an oar for each boat. A sponge hook is simply a two pronged hook, varying somewhat in size, according to the size of the sponge to be taken. The water glass is a box about twelve inches square with a glass bottom. In the beautifully transparent waters of the Bahamas, this glass, when placed against the surface causes the water to become a kind of lens so that objects as large as sponges are plainly visible in twenty-five or thirty feet of water.

The vessels are supplied with provisions by the crew themselves. When ready, she sails to some well known sponge bank often fifty or sixty miles distant from Nassau.

Arriving on the bank, the vessel is anchored in as sheltered a portion as possible, the boats are put out, each manned by two men. One man skulls the boat, in so doing he stands upright and uses a single oar which acts as a propeller. When once on ground favorable for sponges, the speed is slackened while the boat is made to head into the tide. The other man now takes his place in the bow, water glass in hand, the boat is held in position by the man with the oar, while his companion, still keeping his glass on the water with one hand, raises his sponge hook with the other, drops the iron-tipped end in the water, hooks the sponge and draws it to the surface, then transfers it to the boat.

As related above, this operation appears simple, but is really quite difficult in actual practice. Both men must be experts in their business, in fact, it is no light task to keep a boat in absolutely one position without varying a single inch against a swift tide, and often in a cross sea. Yet a skilled oarsman will do this with his single oar, often keeping the boat accurately over one spot for several minutes at a time.

Second, he who hooks the sponge has even a more difficult task. He must have an educated eye to begin with, in order to recognize a commercial sponge among hundreds of others which grow scattered over the bottom. One seen the heavy shaft, often thirty feet long, must be raised perpendicularly and dropped with a precision on the side of the sponge where the current flows against it. This must be accomplished in a swiftly flowing tide, and the sponge hooked without a single mistake, in spite of the refraction caused by the water. Although I have had considearble practice in gathering sponges, and other animals in water ten or fifteen feet deep, I have found that it is utterly impossible for me to handle a sponge hook successfully at greater depths. In spite of every effort, the pole was swept forward by the flowing water before I could get the hook to the bottom at the desired point.

As soon as the boat is filled with sponges, or night comes, the cargo is taken to the vessel and thrown on deck. When a sufficient quantity has accumulated on deck, the sponges, now dead and in a partly decaying condition, are transferred to the hole. As has already been related, living sponges have a very disagreeable odor, and this is greatly increased when the sponges die. Thus the stench which arises from a sponging vessel is so intense that it can be perceived when one is passing a long distance away, especially to the leeward.

On Saturday, no matter whether the vessel be full of sponges or not, she sails for the nearest land, anchoring near what is known as a sponge camp. This camp is usually situated at a point near the entrance of a lagoon or bayou. Here in the sea in a place where the tide flows into a water course, two or more, of a kind of pen, made of wicker work are erected. These are known as sponge crawls, and in them the sponges taken during the week are placed.

These crawls being situated at the entrance of tide ways are swept four times a day by the incoming and outgoing tides. This nearly constant flow of water tends to wash out the animal matter from the sponges. This is quite easily accomplished, as the sponge flesh decays very rapidly when it liquifies.

The sponges are left in the crawls for one week, then upon the arrival of the vessel with the second cargo, for she sails for the sponge bank on Monday morning before day break for a fresh supply, they are removed, but before this, what little sponge flesh remains after this washing, is beaten out by men who enter the crawls for this purpose. No clothing can be worn when beating out sponges, for although the commercial sponges are composed wholly of horny matter, the sponges take in numerous spicules left by the spiculigenous sponges in the water, and clothing assists these spicules to enter the flesh.

When the first crop of sponges is washed, they are placed upon a clean bed made of the fronds of a species of palm which grows abundantly on many of the Bahama Keys. When these sponges are dry they are sorted, each species not only being kept by itself, but the different qualities of each kind are kept apart.

These sponges are left in heaps until a cargo is secured, or until the provisions are exhausted. It speaks well for the honesty of the spongers in general, that these sponges are left wholly unguarded when the vessels are away securing other cargos. The next operation is to place the sponges upon strings made from the fibrous fronds of the same species of palm which are used as a bed. Then they are ready for market.

While it is true that the best and finest sponges come from the Mediterranean Sea, it is also true that many fine species are found in Florida and

Bahama waters. There are several species of sponges found in American waters which are used for commercial purposes. One of the best is the Violet Sponge, a tough, elastic species with a fine fiber, and which does not grow to a large size. Then follows the Lambs Wool Sponge which is not quite as fine, and which often grows to a large size, sometimes a foot or more in diameter. The Glove Sponge is also a fine sponge, rather small, and often sold as a bath sponge.

The little Reef Sponge, most often used for a Slate Sponge in our schools, is quite fine, but it never grows very large.

The coarsest sponge of all is the Grass Sponge, which also grows to a large size, and is used for a variety of purposes, being sometimes ground up to make an inferior kind of felt, which is used for the manufacture of cheap hats. A finer fibered sponge, is the Pipe Sponge, also sometimes used for this purpose, but in this species the fiber is not tough enough to resist much handling, and consequently this sponge is seldom used as a toilet sponge.

After securing a cargo, the vessel sails for Nassau. Upon arriving at that port, the sponges are carried to what is known as the sponge mart or market. Here they are placed in bins, each species by itself. It is an interesting sight to walk down the long corridor between these bins, and note the different species of golden colored sponges, which are piled in them.

All the sponges are sold at auction, and when bought are taken to warehouses where the bases are clipped off in order to remove any bits of rock etc. which may adhere to them. They are then pressed into bales and shipped all over the world.

The first price paid for sponges in Nassau averages about one dollar per string, each string weighing one pound, and as it takes about twenty sponges which are about six inches in diameter, to weigh a pound, the sponger makes barely enough money to suffice for his scanty living, from twenty-five to fifty cents a day being about what is earned by each man. These wages also have to suffice to keep the sponger and his family during July, August and September, which are known as the hurricane months, when all the vessels are laid up in harbor, and no sponges are gathered.

PARASITES OF HORNY SPONGES.

As already remarked, we find that one species of sponge often grows upon another, but this does not imply that they are parasites in the most correct sense of the term. That is, it is not at all probable that one sponge derives any nutriment from another: it simply grows upon another sponge just as it would grow upon a rock or other base.

Few living animals are without true parasites, and the sponges are no exception to the rule. One of the most conspicuous parasites of the Horny Sponges is a long sea worm which lives in the excurrent orifices of several species of sponges. One of the most singular things about this worm is that it makes a kind of tube in which it lives. The walls of this tube are very thin, and when it is removed from the sponge and dried, resemble paper. This tube differs from that made by most species of worm which are usually continuous, without branches, inasmuch as it sends ramiform branches into the various excurrent tubes of the sponge. The worm has to fold its body many times in order to occupy all of these branches, and I have found a worm which measured nearly or quite two feet in length, living in a sponge not more than six inches in diameter.

I consider this worm as a parasite inasmuch as it lives within the orifices of the sponge. It is possible, however, that it may not receive any nutriment from the sponge itself, nor from any substance that the sponge may absorb. The protection afforded by the sponge may be all that the worm desires, yet it must be in a great measure detremental to the sponge, for it occupies portions of the tubular system in which the water should circulate freely. The worms enter the sponges by boring into them from between their base and the rock on which they grow.

The sponge most frequently attacked by this long sea worm, is the Loggerhead Sponge, in fact, I never examined a living specimen of this species which did not contain one or more of these parasites.

One of the most usual internal parasites of the Tube Sponge, is a small worm about .10 in length, which lies encysted (that is, enclosed in a kind of sack, probably formed by the sponge) in the sarcode, among the tubes of the water system. (See Fig. 3, D, o, where I have given an example of this worm considerably enlarged) So abundant are these intruders, that it is impossible to cut a sponge of this species (Tube Sponge) in any direction without encountering one of them.

Regarding the power which sponges have of encysting objects which have been introduced into the sarcode, we find that sand is often taken into the waer system, probably through the incurrent tubes. This sand appears to be passed through the sarcode, where loose pieces may be found, until it is accumulated in small parcels when it is encysted. (See Fig. 3, v, v, page 13, where I have given two of these encysted parcels of sand: also fig, 9, to the right of a, where I have shown a sand cyst which has either interrupted the course of a water tube, or has caused it to become absorbed at its inner termination, during the progress of the accumulation of the sand, the latter hypothsis being the most probable.

Although the passage of foreign matter through the sarcode of sponges to become finally encysted at particular points, may be akin to a similar process in the amoeba and other equally low forms of animal life, where the food is gathered in ball-like parcels, (See Fig. 4, page 15, where is given a greatly enlarged diagram of an amoeba: the unlettered circles being the food balls,) yet in both of these there would appear to be some kind of nervous energy, which in the case of the amoeba, is the origin of that impulse which gathers the food in balls, and expels that portion which is not absorbed, and in the case of the sponge, which passes the intruding sand through the sarcode to become finally encysted. The origin of the impulse which causes the amoeba to move, grasp food or propagate by division, and which originates the impulse which causes the motion of the cilia in the cells of all species of sponges and which causes some species to shrink upon being handled, (See page 43, under Habits of Horny Sponges) must also be something akin to nervous energy, although that something is so subtle that it has up to date evaded the investigation of the most careful microscopist, even though he be provided with the best instrument which skilled labor can give him.

A small, short-legged crustacean also occurs in the water system of the Tube Sponge, and a small species of sea weed is quite often found attached to old sponges.

SPICULIGENOUS SPONGES.

As already remarked on page 9, that although the sponges which are provided with spicules, are usually separated by specialists from the Horny Sponges which are without spicules, which are produced by themselves, the division is hardly a natural one, for there are a number of species which are direct intergrades between the two groups. But as there are a great number of sponges which do not have spicules, and a larger number which very decidedly do have, it is perhaps as well to group sponges as Horny and Spiculigenous.

Spiculigenous Sponges then, as a rule, differ from Horny in having the horny fibers more or less supplemented by spicules. These spicules vary in number from sponges in which they are scattered sparingly through the horny matter, to species which are wholly made up of spicules.

Examples of spicules may be seen in Figs. 31 and 32. There can be no doubt but what the use of these spicules is defensive, that is, they prevent the inroads of parasites. Although, as will be seen by referring under the heading Parasites of Spiculigenous Sponges, these sponges are not quite free from parasites, yet I have never seen a sponge of this species which contained any parasitical worms of any kind.

The Spiculigenous Sponges may be divided into two groups which are perfectly natural. One in which the spicules are composed wholly of silica, and one in which the spicules are calcareous or composed of lime. As far as recent sponges are concerned, the line between these groups is sharply drawn; that is, we do not find any sponges in which the spicules are composed partly of silica and partly of lime; they are composed wholly of one or the other. Hence we have first: –

SILICIOUS SPONGES.

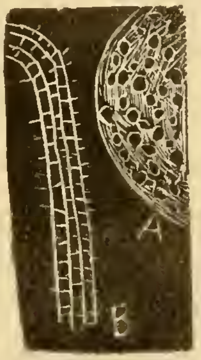
Sponges in which the spicules are composed wholly of silica. This group, by the environment, is divided into two groups; Salt Water Silicous Sponges, and those which inhabit fresh water.

SALT WATER SILICOUS SPONGES.

These sponges vary from; First, in which the spicules are scattered sparingly over the horny net-work of the fiber, as seen in the Gray Cup Sponge (Fig. 23, page 38) a species in which the horny fiber is drawn out in long thread-like filaments, which run parallel to one another, and which bend outward at their terminations. From these filaments project the spicules, much as do the thorns on a rose bush. See Fig. 33, B, where I have given a cut of these fibers much enlarged.

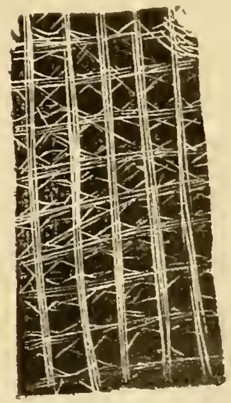
Second, species in which the sponge is made up nearly wholly of pure silica. Examples of this kind of sponge may be seen in the Glass Sponge, and in the well known Venus Flower Basket (Euplectella) which is composed of long parallel filaments of silica connected by other cross filaments. As all of these filaments are composed of transparent, glass-like silica, the sponge appears to be made of delicate lace work. This sponge occurs in the seas about Japan, and so singular is its structure, that it was for many years supposed to be an artificial product of the Japanese, See Fig. 34, where I have given a life-sized section of this sponge,

Fig. 33.



A, portion of shell excavated by mining sponge. B, fiber of Gray Cup Sponge.

Fig. 34.



Section of Venus Flower Basket.

WATER SYSTEM OF SPICULIGENOUS SPONGES.

There is less sponge flesh on the skeletons of many living Spiculigenous Sponges than on those of the Horny Sponges, but this is somewhat variable. some, in the case of the common Branching Sponge of our coast (See page 35, B) there is very little, while in some of the typical species, the sarcode is nearly or quite as abundant as in the Horny Sponges, The water system is rather more difficult to make out in these sponges than in the Horny Species. The incurrent openings and cilia cells are much smaller, and the connection between these cells and the excurrent system is somwhat obscure.

In one of the southern sponges of this group, which I found in Nassau Harbor, Feb. 1897, a singular species, which in mature specimens has no attachment for any object, but rolls about on the bottom, and which I believe to be undescribed, for I can find nothing answering to it in any of the works on sponges, under a common magnifying lens the surface shows numerous granulations, among which are depressions, in each of which is an orifice very minute and evidently with a closing membrane. (See Fig. 35, A, where I give five of these orifices.) Each of these orifices opens into a tube which passes through a dense, hard skin which measures about .15 in thickness. Inside this skin, which is black in color, we find the tubes opening into a soft, fleshy mass, which is grayish orange in color, and filled with numerous needle-like spicules which cross one another in all directions without any apparent systematic arrangement. Among these spicules are many connected tubes, small in size, none more than about .05 in diameter, but which are occasionally enlarged into cells which must be occupied by cilia. As there are no orifices on the entire surface of the sponge, larger than I have described above, some of these must be excurrent openings and some incurrent, but the whole system is so complicated, that it is difficult to trace any of the tubes with certainty. (See Fig. 35, B, where I have given a slightly enlarged view of a section of the outer covering of this sponge, and some of the tubes within.)

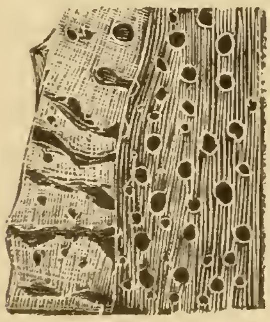
On the other hand, in a sponge of the genus Tuba, the Finger Sponge, of which I have given a cut on page 42, Fig. 27, the upper figure being size of life of a single tube, and the lower of a cluster of tubes reduced, a section through the sponge shows the water system clearly. Here, however, there do not appear to be any distinct excurrent openings. The whole outer surface of the sponge is covered with a kind of closely fitted fiber through which water is admitted to the water system within. This consists of a series of cells which are either continuous or are closely connected by tubes, one within the other, so that the whole system passes directly through to the excurrent openings, which open into the large central tube, much as does the water system in the Tube Sponge. (See page 11 to 15, and Figs. 2, 3 and 9.)

The cilia cells are, as a rule, smaller than in Horny Sponges. Here in them we also find the typical collar cells, which will probably also be found to occur in all sponges. These cells surround the upper part of the pseudopoda-like process which I have given in fig. 5, page 15, and from them are thrust out long, whip-like cilia which are constantly in motion, and which not only cause the flow of water through the tubular system of the sponge, but which also gather food from this water, and by withdrawing, carry it into the interior of the psuedopoda-like process, where it is passed into walls of the cavity to become absorbed, much as food is passed into the body of the amoeba. When the nutritious matter contained in this food is digested, the refuse matter is passed out and flows onward with the water, and out of the excurrent openings, See Figs. 2 and 3, c, c, page 13.

This arrangement of cilia may be seen by referring to Fig. 37, where I give an ideal section of one of these cells, greatly enlarged, with the numerous cilia, and in Fig. 38 is given a much more enlarged cut of a single whip cell, and its long, slender process known technically as the flagellum ; A, B is the thin collar, C, the base of the whip cell into which the food is passed for digestion.

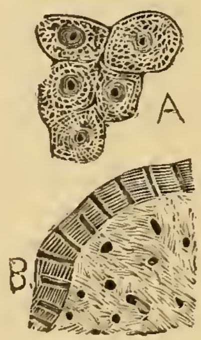
As already remarked, it is the motion of these cilia which draw the water

Fig. 36.



Section of Finger Sponge showing water system.

Fig. 35.



Spiculigenous Sponge. A, excurrent openings ; B, section of outer portion, both enlarged.

into the tubular system through the incurrent tubes, and expel it out of the excurrent tubes.

FORMS OF SILICIOUS SPONGES.

Sponges of this group which occur in salt water, are quite variable, and their method of growth is also quite variable. On page 31 I give a figure of a

Scarlet Sponge (Amphimedon variabilis D. and M.). This sponge is made up largely of fiber which is almost paper-like in consistency, and which becomes very white upon exposure to the sun. These fibers are quite flat, and are supplemented by numerous, very small and fine needle-like spicules. The form of this sponge is quite irregular, depending somewhat upon the exact spot in which it grows. That given in Fig. 19 has mound-like projections from which open the excurrent tubes, but these become larger in the beautiful colored specimen given on plate IV.

On page 35, B, I have given a portion of the Branching Sponge (Chalinula oculata Bow.) of our New England coast. This species has a fine mesh-like skeleton upon which there is little sarcode at any time. The larger orifices seen in the cut are the excurrent, the incurrent being very small. This sponge shows the branching form of a Spiculigenous Sponge, a form which is also assumed by the Horny Sponges. (See A, in cut on page 35.) The branches of the Chalinula anastomose where they come in contact.

On page 38, Fig. 23, is given a cut of the cup form of a Spiculigenous Sponge. This species has coarse fibers which run longitudinally with short, cross connecting fibers. The long fibers turn outward at their extremeties. (See Fig. 33, B, page 61.) This sponge is quite variable in form when young, or when placed under circumstances which are not favorable for its development. At such times, a portion of the cup-like form only is developed. When fully grown, this sponge measures ten inches in diameter and about the same in height. This is called the Gray Cup Sponge (Cribrochalina infundibulum D. and M.) This species has but little sarcode. It occurs in Bahama waters.

On page 38, fig. 24, is given another Cup Sponge, the Green Cup. This is also a coarse species, with the fibers projecting outward, much as in the Horny Sponges of the genus Hircinea, (See Fig, 18, page 31) and which borders the margin of the cup in fringe-like clusters. See Fig. 24, C. This species has very little sarcode, even in life. The cups are almost always detached, although some occur in clusters. They measure from six to twelve inches in height, and occur in Bahama waters.

On page 40, fig. 25, is given a singular sponge known as the Palm Sponge, of the genus Pandaros. This is a small species, never growing to be over four or five inches long, and spreads out into a palm-like structure. The skeleton is coarse, but well covered with sarcode.

Another singular species, as far as skeleton is concerned, is the Crimson Branching Sponge. (See page 42, fig. 26). This grows in branching, anastomosing clusters, rather flat in form. It belongs to the genus Pandaros, and occurs in the Bahamas.

Another Bahama Sponge of the genus Pandaros, is the Red Sponge, also known as the Coral Sponge, given on page 40, B. In life it is so covered with sarcode as to appear shining and plump, but the fibers occur in transverse, clustering lines.

Beside it, in Fig, 28, A, is the beautiful Purple Sponge (Pachychalina rubens Schm.) in which the excurrent opening are very prominent. The fiber of this sponge is very fine, and the water system easy to make out in cut sections, for the incurrent orifices open through a fine net-work of fibers into a series of cells which radiate out quite regularly from the excurrent tubes. It occurs in abundance in rather deep water in Nassau Harbor.

On page 42, Fig. 27, I have also given a Spiculigenous Sponge, the Finger Sponge, (Tuba vaginalis Smitz.) This species varies from finger-like tubes, which have a smooth, or nearly smooth exterior, (See lower figure) to tubes on which are developed thorn-like processes. I have given a cut of the water system of this species on page 64, Fig. 36. This species has little sarcode.

Another very remarkable sponge is the Creeping Sponge (Smitza aulopora) which grows on the bottom, in remose branches, often two feet or more long. Although the excurrent openings are very apparent, (See Fig. 29, page 44) the water system is made up of minute cells, and is very difficult to trace. The skeleton is made up of fine friable, mesh-like fibers which are beset with fine spicules. This is rather of a rare species, locally distributed in Bahama waters.

Another minor group of the Spiculigenous Sponges, is the Mining Sponge. It is not uncommon to find on our New England Coast, shells of Mollusks which are pierced with holes (See Fig. 33, A, page 61, where I give a small portion of one of these shells) These holes are made by a Mining Sponge when in its young stage. When older, it spreads outwards, often for several inches, and encloses small stones and other hard substances within its meshes.

Another group of Silicious Sponges are the Incrusting Sponges belonging to the genus Terpios. These species spread over dead coral, stones and other objects in the sea, much as lichens spread over stones, trees, shrubs etc. on the land. The thickness varies from .10 to .50 of an inch. See plate V, where I have given the figure of a fine specimen of the Green Incrusting Sponge, Terpios fugax D. and M.

ODOR OF SPICULIGENOUS SPONGES.

Although these sponges have an odor which somewhat resembles that of the Horny Sponges, it is seldom as strong. The Palm and Common Branching Sponges have a rather sweetish scent which is not unpleasant, while the Purple Sponge has an odor which is not disagreeable.

HABITS OF SALT WATER SPONGES.

These sponges occur in all depths of water, from between tide marks to fifty feet or more deep. Some species are habitual parasitical, others like the Purple Sponge, occasionally grow on other sponges, but as far as my experience goes, Horny Sponges are always selected as a base of growth, for I have never seen a sponge of any species growing upon a Spiculigenous Sponge.

Another peculiarity observed in members of this group, is that they do not appear to display much, if any, perceptible sensitiveness upon being handled: in fact, I have never seen any species of Silicious Sponge close the excurrent orifice, even when removed from the water.

A matter which is of great interest in regard to this group of Spiculigenous Sponges, is the power which they possess in the spicules as a protective medium. As shown, the spicules seem to afford them protection against the inroads of internal parasites, and to ensure them against the attacks of parasitical sponges of all kinds. Some species of Spiculigenous Sponges have the spicules so well developed that they are exceedingly disagreeable to handle. There is, for example, a species which grows between tide marks in Nassau Harbor, which is almost wholly made up of slender spicules which project from the surface. (See Fig. 39) When these sponges are handled ever so lightly, the points of the spicules enter the flesh and break off there, and after a time produce a burning sensation, and the skin of the hands, especially between the fingers, becomes red and inflamed, exactly as if the spicules contained some poison, in other words, the irritation produced by them is more than would be produced by the presence of thorns, or better, the prickles which grow in clusters on the fruit of the cactus, known as the prickly pear.

In regard to the habits of particular species of Silicious Sponges which occur in the sea, I give the following account of some of the typical species as I have observed them.

Scarlet Sponge. This beautiful and striking species grows on banks, usually embedded in mud, with no particular basal attachment for any hard object. But as the substance of the sponge is soft and easily injured, we generally find that the sponge avails itself of the support afforded by a branching species of nullipore and broken seaweed and other debris. See Fig. 19 where the nullipores etc. may be seen projecting from the base. Another support which we frequently find in this sponge is a species of living worm shell, which have never found elsewhere than in sponges. This shell begins life as a spiral gasteropod, but after growing to the length of a half inch or a little less, begins to send up a tube much like that occupied by some species of marine worms, the entrance of which the animal appears to be obliged to keep upright, hence it avails itself of the support afforded it by some species of sponge: as the fibers and flesh of the Scarlet Sponge are soft, the worm shells select it as a dwelling place. The Mollusk adds to its tube as the sponge grows, thus its entrance is always kept on a level, or a little in advance of the upper surface of the sponge. The sponge clings so closely to this seeming intruder that the shell cannot be removed without tearing away some of the sarcode and fiber of the sponge. Thus the sponge finds the support, which it desires in the shells, nullipores etc. which form a kind of skeleton for it, while the Mollusk finds the sponge admirably fitted to keep its crooked shell upright; thus sponge and shell are of mutual benefit, and I have found as many as six worm shells in a single small Scarlet Sponge.

The Branching Sponge of our coast grows attached to bridges or wharf piles, usually just below low water mark or deeper, or to stones at greater depths. They are usually found in upright branching, anastomosing clusters.

The two Cup Sponges, figured on page 38, occur in from twenty to thirty-five feet of water, almost always in tide ways, but usually where there is some obstruction like a small coral reef or bank, which breaks the full force of the tide. The Green Cup has a slight attachment for the rocky base upon which it grows, but the Gray Cup is more firmly attached.

I have found the Palm Sponge, (Fig. 25) growing on a shallow bar near the entrance of the Narrows, a strait between Hog Island and Athels Island, near Nassau.

The Branching Crimson Sponge, (Fig. 26) I found growing in deep water near Allen's Harbor, a cluster of lonely, uninhabited islands, which lie on the Atlantic side of the Bahama bank, east of New Providence, distant some thirty miles. Both this species and the Palm Sponge give out a crimson fluid upon being handled, which stains the hands to such an extent that it is difficult to clean them. This emission may be voluntary, or may result from a shrinking of the sponge, which is, however, too slight to be perceptible to ordinary observation.

The Finger Sponge (Fig. 27) grows in deep water, thirty feet or more, in sheltered places, firmly attached to rocks, usually in more or less branching clusters. See lower cut, Fig. 27.

One of the most beautiful sponges in Bahama waters, is the Purple Sponge, (Fig. 28, A.) This usually grows upright, sometimes branching but not often in clusters. I have also found it creeping along stony bottom, It occurs in swifter tide ways than most sponges, and has a very firm attachment for the rocky base. It is quite generally distributed about the Bahamas in suitable places, but is very abundant in Nassau Harbor. Associated with this sponge, often living beneath it or clinging between its branches, I have found a species of Brittle Starfish having long, spiny processes and colored purple lake, very nearly like the sponge with which it lives.

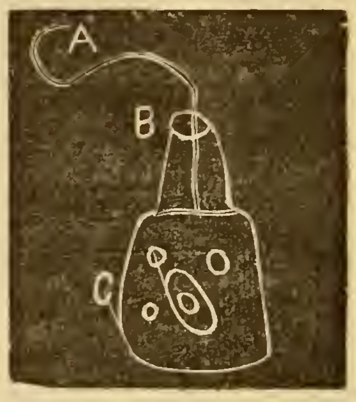
The other species given in Fig. 28. B, the Red Sponge, is one of the most strikingly beautiful sponges found in the Bahamas. It is shining red in color. and resembles branching coral, and this similarity is heightened by the fact that this sponge grows in anastomosing, branching clusters, but usually creeps or is supported by dead coral etc.

The Creeping Sponge (Fig. 29) is another peculiar species, which lies

Fig. 37.

Ideal cilia cell of Silicious Sponge.

Fig. 38.



Single cilia of Silicious Sponge.

prone upon the bottom in lagoons and bayous, but never in very swift tide ways. It has very little attachment for the bottom, for all that I have found could be quite easily lifted up with a sponge hook.

COLOR OF SALT WATER SPICULIGENOUS SPONGES.

In this group are some of the most highly colored species in the world, vying in this respect with the brilliantly colored fungi of the land.

Taking the sponges in the order given under habits, we find in the Scarlet Sponge a brilliant species, of which some idea may be given upon referring to Plate III. This color varies somewhat with individuals.

The Scarlet Sponge changes first to greenish, upon drying, and then to white.

The Branching Sponge of our New England Coast, is pale yellow in life, and bleaches somewhat upon drying.

The color of the Gray Cup Sponge in life is pale brown, with spots of pinkish and this color changes to a pale brown.

The Green Cup is a deep olive green in life, changing to a greenish brown in drying.

Both the Palm and Crimson Branching Sponge are deep purple lake in life, but change to black on drying.

The Finger Sponge is always gray living, and remains the same color when not exposed to the direct rays of the sun for too long a time.

The Purple Sponge is, as its name implies, of a deep purple lake, and this color remains in a great measure, in dried specimens, which are not exposed to the sun.

As already remarked, the Red Sponge is bright, shining coral red, but dries whitish.

The Creeping Sponge is pinkish yellow, drying about the same.

A few species of the Spiculigenous Sponges are black, but by far the greater number, as seen, are brightly colored when living. The Incrusting Sponges vary from black, brown and bright red to green. See Plate IV, for the color of the Green Incrusting Sponge.

GEOGRAPHICAL RANGE OF SILICIOUS SPONGES.

The geographical range of sponges of this group is much more extended than that of the Horny Sponges, for they are found from the Arctic to the Antarctic Circle, but are far more abundant in Tropical and sub-tropical waters than elsewhere. In the West Indies, for example, the species outnumber those of the Horny Sponges.

FRESH WATER SILICIOUS SPONGES.

If we search in fresh water streams, ponds, or ditches, which do not become dry in summer and which are plentifully supplied with pure spring water which is not hard, that is too much impregnated with carbonate of lime, we shall usually find clinging to the sides of submerged stones, to sticks, stumps, etc. greenish or brownish masses which have a strong, but not to many, a disagreeable odor. These are Fresh Water Sponges. Their forms are variable, from delicate branching structures, only an inch or two in length, to large, flattened masses, often a foot or more in diameter, and two or three inches in thickness.

Under a microscope with moderate power, say fifty diameters, these sponges will be found to be made up of bundles of spicules, which are usually spindle shaped. See Fig. 32, P. page 46, also Fig. 39, C, where I have given the spicules taken from a member of the genus Spongilla, which was collected in a pond in Newtonville. In the figure last mentioned, the spicules are seen to be hollow, which is the natural condition of them in most of the sponges.

If these sponges be gathered in late autumn or winter, they will be found to be provided with seed-like bodies which lie within the sponge, or at its base and which can easily be seen by the aid of a common magnifying glass.

These are the winter ovules, and they are surrounded by peculiar spicules, sometimes bent, one of which highly magnified, I have given on page 46, Fig. 31, A, and at B is given some of the ovules considerably enlarged. Another gemule spicule is given in Fig. 39, D.

Upon a microscopic examination of these ovules, they will be found to be made up of minute ova which in the spring develop into ciliated animals, which, bursting the ovule case, swim about freely for a time, but eventually become fixed and produce other sponges.

The water system of Fresh Water Sponges is essentially the same as that given already in the Salt Water Silicious Sponges, but it is even more difficult to make out, and there is little or no horny fiber.

HABITS OF FRESH WATER SPONGES.

I have found the Green and Branching forms of Fresh Water Sponges growing on sticks in the bottom of ditches, or clinging to the sides of stones in ponds. Upon examining the bed of a mill pond in Newtonville after the water had been drained off, I found large, flattened masses of a species of Spongilla a foot or more in diameter, clinging to the roots of some willows, which, as is often customary with these trees, had sent their roots out into the water in large clusters.

COLOR OF FRESH WATER SPONGES.

As intimated, most of the Fresh Water Sponges are dull in color, the brightest among them being a rather bright green. This greenish color appears to vary somewhat with individuals. Those which grow in situations where they are exposed to the full rays of the sun are the brightest, while those even of the same species, which grow in shady places are sometimes nearly white. The large, flat species of Spongilla are brown in color, and have been spoken of by writers as resembling masses of liver.

LIMY SPONGES.

In these sponges the spicules are composed wholly of carbonate of lime, but do not differ greatly in other respects from Salt Water Spiculigenous Sponges. They are usually small in size, often not over an inch in length, and are rather simple in structure. See Fig. 40, where I have given an example of a Limy Sponge of the genus Grantia, A, being the sponge entire, and B a section where the spicules may be seen projecting from the ends.

As will be seen, the water system is very simple, the incurrent tubes opening into a circular system of tubes which pass directly through to the cloacal or central tube. See Fig. 41, where I give a section of one of these sponges greatly enlarged. A is the incurrent tube, B, the excurrent tube opening into the large central tube.

HABITS OF LIMY SPONGES.

Limy Sponges are usually found in abundance in our New England Waters in the shade of docks, bridges, and wharf piers and on sea weeds, but almost always out of the direct rays of the sun.

COLOR OF LIMY SPONGES.

All of the Limy Sponges which I have seen were either white or pale yellowish, and this absence of color would appear to result from their habit of living out of the sunlight. They always occur in moderately shallow water.

GEOGRAPHICAL RANGE OF LIMY SPONGES

It is highly probable that Limy Sponges have about the same range as Salt Water Silicious Sponges, throughout the temperate, tropical and subtropical seas, but do not extend as far north nor south.

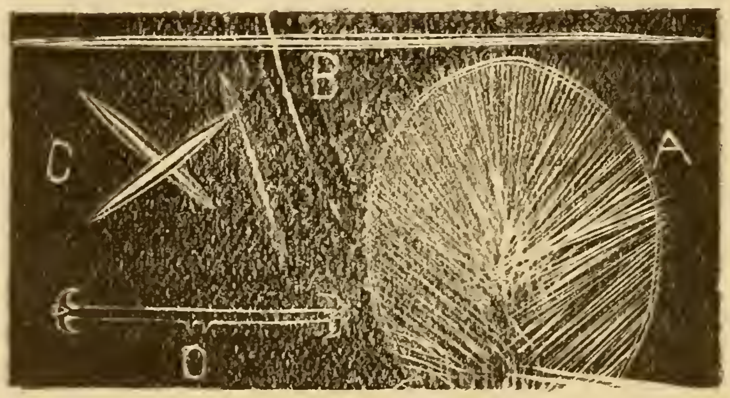
SPONGES WITHOUT FIBER OR SPICULES.

Sponges which fall under this head are peculiar, inasmuch as they have neither fiber nor spicules. The substance of the sponge appears to be made up wholly of sarcode through which penetrates the water system. See Fig. 41, A, where I give a greatly enlarged section of one of these sponges, showing the water system. B shows the surface of the sponge which appears granular. Both cuts are magnified about fifty diameters.

HABITS OF FLESHY SPONGES.

These sponges grow attached to rocks, often spreading completely over them. They appear to propagate partly by buds which are liable to appear on any portion of the sponge. When living and undisturbed, they are very soft and compressible, but shrink very perceptibly upon being handled, and then become hard and rigid. In life, the excurrent orifices are plainly visible,

Fig. 39,



A. section of Spiculigenous Sponge, life size. B, single spicule of same greatly enlarged. C and D, spicules of Fresh Water Sponge.

appearing as round openings, each surrounded by a mound-like elevation. These close so completely that all traces of them are lost when the specimens are placed in formalin.

COLOR OF FLESHY SPONGES.

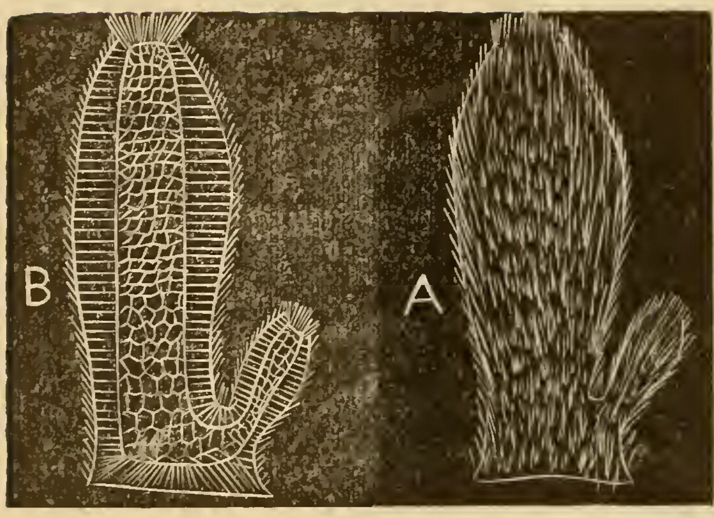
There is one species of sponge of this group which occurs in abundance on stones in Nassau Harbor, which appears to vary in color from white to black. depending upon the situation in which it grows: the light colored ones occurring in situations which are sheltered from the direct rays of the sun. This is the species given in Fig. 41.

Another species which grows in Nassau Harbor is dull orange or brownish in color. Others are bright yellow, while a few are bright red.

GEOGRAPHICAL RANGE OF FLESHY SPONGES.

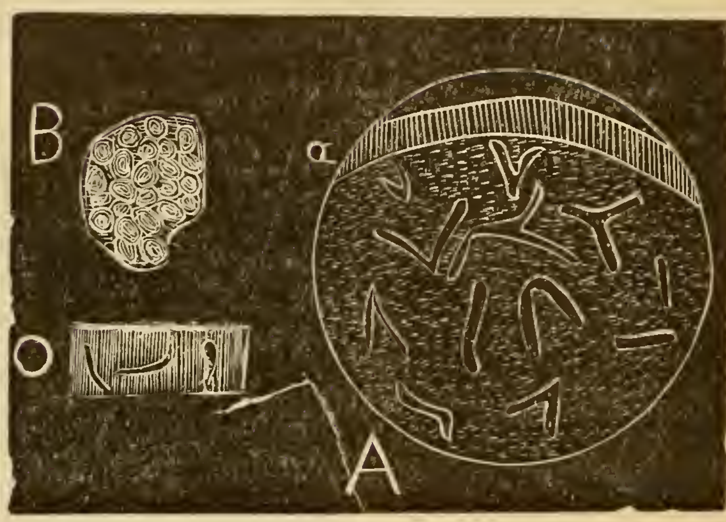
Sponges of this group are, I believe, confined to tropical or sub-tropical waters, and grow mostly in comparatively shallow water, but never, as far as I have seen, where they are exposed to the falling tide.

Fig. 40.



A, Limy Sponge. B, section of same.

Fig. 41.



A, section of Fleshy Sponge, showing water system: B, portion of entoderm, from above: O, same in section; all figures magnified about 50 diameters.

SPONGES IN TIME.

Looking backward through the past ages, we find that sponges began in the lower silurian age, were abundant in the oolitic and cretaceous periods, as their remains testify, and so continued into the tertiary, up to the present age. It is highly probable that the first to appear were the Spiculigenous Sponges, for the remains of these constantly occur, even in the silurian rocks.

SPONGES IN HISTORY.

Sponges appear to have been used for domestic purposes from very early times, in fact, the name sponge is derived, according to Johnson's History of British Sponges, from a Greek word which signifies " to squeeze ".

Homer, in the Iliad, alludes to the sponge as an article of toilet use, but its scientific history begins with Aristotle. He speaks of three kinds of sponges; one very fine, called Achilleum, another hard and rough called tragos, and another which was called aplysiae because they cannot be washed clean. He appears to be undecided in opinion whether to consider them plants or animals, or probably it would be most correct to say that he considers them neither, but as a kind of intermediate between the two.

Pliny who, although he copies most of his account of sponges from Aristotle, is never afraid to give an opinion of his own, seems to consider them as animals. At first he declares they have a third or middle nature, and are neither living nor yet plants. This statement is evidently derived from Aristotle, but later comes his own idea, for he declares most emphatically that sponges not only have life, but a "sensible life" for it is found that they have blood settled within them. He also decides that they have the sense of hearing which causes them to draw in their bodies at any sound, thereby squeezing out water contained within their tissues. He says that they cling so hard to the rocks that they have to be cut away, and that they then shed blood plentifully, or that which resembles blood quite closely. Pliny further gives us the idea that there are two sexes among sponges, and declares that females have the largest pipes, while the males not only have smaller pipes which stand more thickly together, but are also harder.

It is rather singular, considering their method of growth, that sponges should have been regarded as animals by those early writers.

After this, during about a thousand years, when the minds of men were too much occupied in the rapid political and theological changes which the world was undergoing to pay much attention to science, such insignificant things as sponges were entirely overlooked, and when with the renewal of science, natural history began to be studied anew, sponges were regarded in quite a different light.

Gerarde in his Herbal says, "There is found growing upon the rockes neare vnto the sea, a certaine matter wrought together, of the fome or froth of the sea, which we call spunges."

Yet the idea of the animal nature of sponges was not wholly allowed to die out, and this shows how difficult it is to eradicate any idea which has once been published, be it truth or error, for nearly every author who has anything to say of sponges, quotes the opinions of Aristotle and Pliny. Such authors do not neglect, however, to state that they think sponges are not animals.

Thus we find Ferrante Imperato in Historia Natvrale (Venetia, 1682) placing the sponges among the cryptogamous vegetables, stating that he thinks that they are closely allied to the fungi.

Ray agrees with Imperato, that sponges are vegetables allied to the fungi, saying that they live affixed by a root to rocks, shells etc. and if torn away shoot up again from their root and grow as other plants do. (Historia Plantarum, London, 1686).

Marsigli in 1710, although he asserts that he has seen contraction and dilitation in pores of several sponges which had just been removed from the sea, states that he believes sponges to be plants. Shortly after this time, Peyssonel discovered that the hydroids, like sertularia possessed animal life. This appears to have opened the eyes of naturalists in general to the fact that sponges might be also animals.

In spite of this, however, Donati, in his Della Storia Naturale Marina dell' Adriatico (1750) appears reluctant to consider sponges as animals, but accords to them a kind of semi-animality, regarding them as plant animals. Linneaus in the tenth edition of his Systema Naturae, 1760, places the Spongia among the cryptogamous algae, although at that time his views had been well considered.

From his observations made on the American coast, Peyssonel was induced to believe that sponges were fabricated by worms which he frequently found in them. Although this was promptly disproved by Ellis, as late as about 1850, we find Sowerby in British Miscellany advancing a similar theory.

Ellis and Pallas both were thoroughly satisfied as to the animality of sponges, and so conclusive were their arguments that Linneaus in the twelfth edition of the Systema

Naturae (1767) classes sponges among animal zoophytes.

After this date sponges were tossed by authors like a shuttlecock from animals to vegetables then back again to animals.

This shifting back and forth is briefly indicated below. In 1785, Cavolini considers them animals, but very low in the scale. This opinion is maintained by Montagu in 1812. Other authors, like Cuvier and Lamarck followed in this opinion, but in 1824, we find J. E. Gray arguing against the animality of sponges, but the next year he forsook this opinion to consider them animals. Grant, Audouin and Milne-Edwards a little later regard them as animals, but in 1831 we a no less personage than Link, a celebrated Professor of botany in Berlin again placing them among the algae.

In 1841 E. Forbes in some lectures delivered in Edinburg taught that sponges were animal in which life is compound.

In 1842 we find Johnston still uncertain as where to place sponges. After giving a series of arguments, derived from his own observations and those of others, this author says, "There is, however, nothing to forbid us believing with the earliest naturalists, that the sponges may belong to neither kingdom; nay, the very discussion leads to the conjecture that they do actually constitute a middle race, in whose features we can sometimes trace a predominance, now of animal and now of the vegetable nature. Few, on examining the Spongilla would hesitate to pronounce it a vegetable, a conclusion which the exacter observations of the naturalist seems to have proved correct; and when we pass on from it to an examination of the calcareous and silicous genera, the impression is not so much weakened but that we can say with Professor Owen, 'that if a line could be drawn between the animal and vegetable kingdoms, the sponges should be placed upon the vegetable side of that line.' We shall possibly, however, arrive at an opposite conclusion if, proceeding in our inquiry, we follow the silicious species, insensibly gliding on the one hand, into the fibro-corneous Sponge filled with its mucilaginous fishy slime, and on the other, into the fleshy Tethya, in whose oscula the first signs of an obscure irritability show themselves. Sponges therefore appear to be true zoophytes; and it imparts additional interest to their study to consider them, as they probably are, the first matrix and cradle of organic life, and exhibiting before us the lowest organizations compatable with its existence. (" History of British Sponges and Lithophytes, pages 68-69.")

About the middle of the present century, however, the discovery of the cilia and collar cells, with their accompanying whip-like pseudopoda settled forever the question of the animality of the sponge.

The first to call attention to these organs, was Grant in England, about 1841, followed by Bowerbank in 1852. Dujarden and Carter in 1854, Huxley in 1857. In America, Prof. H. J. Clark announced the discovery of the cilia cells in Fresh Water Sponges in 1868. This was confirmed by H. J. Carter in 1879.

The way once opened, a number of other writers have followed in announcing new discoveries in regard to the growth of the sarcode, fiber etc.

For some years after this discovery, sponges were retained among the Infusoria, but about 1870 European writers upon sponges began to consider them as rather higher in rank, and appeared to be inclined to place them in a separate division. In 1875, Prof. A. Hyatt, as mentioned in the introduction, issued his Revision of the North American Poriferae, in the second part of which he says "Since these Memoirs were begun, my views with regard to the affinities of the Sponge 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 structually to the vertebrata, or any of the larger divisions which are characterized by the most important structural differences."

Hackel, a German, in 1872, published a Monograph of of the Calcareous Sponges in which he lays special stress upon the fact that all sponges in common with invertebrates, above the Infusoria, pass through what he terms the Gastrula stage of existence. That is, at one stage of their existence they possess a primitive digestive cavity or stomach (whence the name gastrula) and are then more or less alike. Thus he considers all such animals, beginning with sponges and extending to the lower vertebrates, as belonging to one group, of which the sponges form one division which is closely allied to the corals.

In 1889, appeared Lendenfeld's Monograph of the Horny Sponges, in which he regards sponges as much higher than the Infusoria, in fact, they constitute a group of the coelenterata, (corals, jelly-fishes, etc.) This group, termed by him a Phylm, he proposes to call Mesodemalia. Dr Lendenfeld thinks sponges have highly defferentiated cells, aside from the collar cells, cells in which nervous action originates, others in which muscular action takes place, separate cells for the formation and development of the spermatogoa and ova etc. Two great divisions only are made among sponges. Silicious, among which are included Horny Sponges, sponges without skeletons, and

Calcareous or Limy Sponges. Dr. Lendenfeld's classification of the minor groups among sponges is exceedingly complex and is founded mainly upon microscopical examination of the cells, often regardless of the absence or presence of spicules or horny fiber, that is, sponges without skeletons are often grouped with others which have spicules or horny fiber.

CLASSIFICATION.

I give below my idea of the division and arrangement of the higher groups among sponges.

SPONGES. PORIFERAE.

Metazoan or egg-bearing animals, with three layers, (ectoderm mesoderm and entoderm) of deferentiated cells, prominent among which are the collar cells, and with or without hard skeleton.

Class I. Calcareous Sponges.

Skeleton always present and composed of spicules of limy matter.

Class II. Silicious, Horny, and Fleshy Sponges.

Skeleton present or absent, and when present is either composed wholly of spicules of silica or horny matter, supplemented with spicules of silica, or wholly of horny matter.

ORDER I. MARINE SILICIOUS SPONGES.

Skeleton present, composed either wholly of spicules of silica, or partly of silicious spicules and partly of horny fiber. Inhabit sea water.

ORDER II. FRESH WATER SILICIOUS SPONGES.

Skeleton present, and composed largely of spicules of silica. Inhabit fresh water.

ORDER III. FLESHY SPONGES.

Skeleton, wholly absent. Inhabit sea water.

GENERAL CONCLUSIONS.

We find that a sponge is an animal with several sets of similar organisms, which are probably controlled by nervous force, and which act in harmonious concert in certain emergencies, just as the organisms of higher animals act under like circumstances. Although reproduction is sometimes accomplished by buds, the young are mainly derived from ova, consequently the sponge is a Metazoan and not a Polyzoan, where reproduction is accomplished wholly by division.

There is thus considerable difference between the one-celled animals, classed as Polyzoans and the sponges, while considerable advancement has been made in the scale of animal life.

On the other hand, there is also considerable difference between the sponges and the Hydra, Hydroid polyps, and other polyps which constitute the next province above sponges, and which are scientifiically known as Coelindriata.

LESSON ON SPONGES.

The following is, in a measure, a summary of the foregoing in the form of a lesson, which, although intended for pupils from the higher grade of a grammar school, to those of high and normal schools, may be adapted by simplifying, to lower grades.

A sponge is an animal, fixed when adult, composed of a soft outer covering in which life and motion abide, and which answers to our flesh, and consequently, from a scientific point of view, is the most important organisms to study, and is usually provided with a hard skeleton, which is of rather less importance.

Show a sponge with flesh and a hard skeleton; the ordinary sponge of commerce.

Although not quite natural, it is usual to divide sponges into two groups, Horny and Spiculigenous (for final arrangement, see Classification of Sponges.)

We will first consider the Horny Sponges.

Show specimen which has been preserved in alcohol to illustrate sponge flesh.

Then by the aid of this and cut sections of skeletons, and model of section of a sponge, show the cilia cells, and a blackboard sketch of cilia, and also of the water system (see page 13) and compare cilia with pseudopoda of amoeba (see page 15.)

Let the pupils make drawings of all the parts possible, in order to fix the subject upon their minds.

Show Tube Sponge with dried flesh. Show closing membrane and cloacal tube. Illustrate budding of sponge.

Show skeleton of Tube Sponge, and explain growth by blackboard drawing. Show microscope slides of fiber with hollow center and arrested growths. Show that old fiber cannot anastomose, nor new with old, except by soldering. (See page 27.) Have pupils make drawings, illustrating these parts.

Show fiber of Horny Sponges.

Give an account of the method of preparing Horny Sponges.

Note differences in elasticity between Commercial Sponges and the other forms of Horny Sponges.

Compare a fine Mediterranean Sponge with an American Commercial Sponge.

Note spicules in the specimens and magnified in the slide. Show that they are hollow.

What is the use of spicules? (See habits of Spiculigenous Sponges.

Notice water system of Spiculigenous Sponge, (page 63 and 64) and compare with that of Horny Sponge. See section of Finger Sponge.

Note horny fiber in this and other forms of semi-silicious Sponges.

See fiber in section of Gray Cup Sponge. See Green Cup Sponge, Purple Sponge, note color. See section of Creeping Sponge with fine fiber.

Show Fresh Water Silicious Sponge. Note spicules as magnified in slide. Make drawings of these spicules.

Show Limy Sponge, test with acid, then test Fresh Water Sponge and note results.

Show Fleshy Sponge in alcohol; show by section that it has no spicules nor fiber, but is composed wholly of soft flesh.

State something about the habits of the various groups of sponges.

Speak of reproduction of sponges by buds and eggs.

Give the color of some sponges when living. See Plates I, III, & IV.

Give some idea of the geographical range of sponges.

An idea of the geological range.

The principal points in the history of sponges.

To what conclusion do we arrive in regard to a sponge being a single animal or a colony of animals?

What in regard to its position in the natural system? Also its advancement in the scale?

Give the groups as stated in the final classification.

GENEOLOGY OF SPONGES.

The following is my idea of the derivation of sponges, from vegetables through the Protozoa. This is illustrated by the figure of a geneological tree. Fig. 42

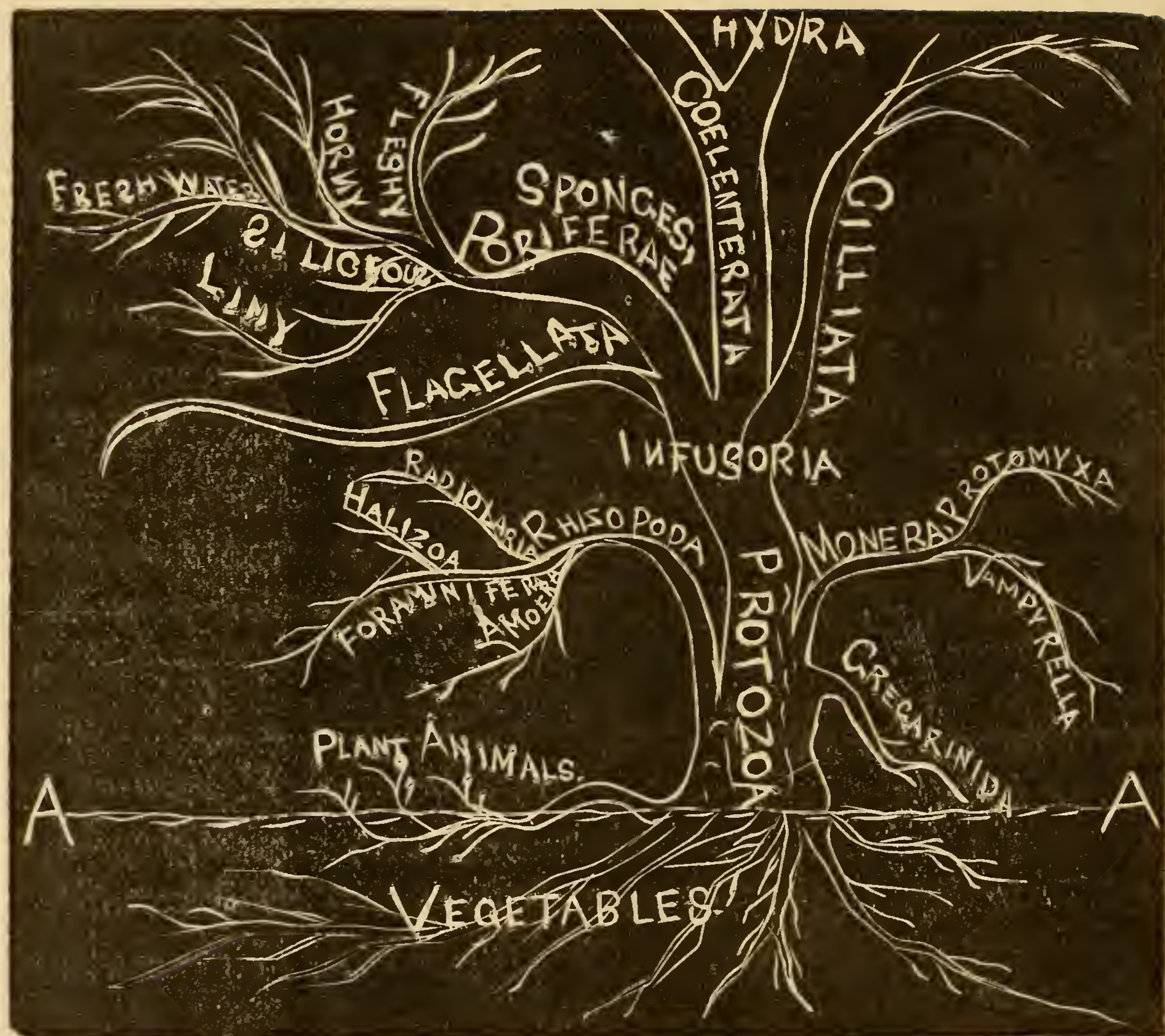
The roots are vegetables, one of which to the left, represents Plant Animals, and this is partly beneath the surface, A ,A, and partly above it where are some incipent shoots.

From the roots arise the Protozoa, First Animals. On the right is sent off a branch which grows downward, the degraded and parasitical Gregarinida, minute animals found in earth worms. Above this, branch out the class Monera, from which arise two groups, the Vampyrella and the Protomyxa, brilliant in color, but very simple in structure.

Opposite, on the left, is the class Rhizopoda from which branch well known forms, Amoeba, Foraminifera, Halizoa and Radiolaria. Above these branches, continues the main trunk as class Infusoria. From this arise two strong branches: on the right, order Cilliata, from the base of which springs the class Coelentreata which continues the life series upward, and on the left, the order Flagellata, from the base of which arises the Province Poriferae or sponges. This continues as Silicious Sponges, giving off twigs above, as Fleshy and Horny, and below as Limy, and further on as Fresh Water.

It will thus be seen that in the upward advancement of the Geneological Tree, sponges are pushed one side on a branch by themselves just as various branches of the Protozoa are given out. In other words, ascending forms of life did not pass through all of these types of Protozoans and lower forms of

Fig. 42.



Tree, Illustrating the Geneology of Sponges.

Metazoans, the ascending stem in its upward progress, passed through changing forms of animals which were the common ancestors of the branches and of the new advanced life which formed above them.

MATERIAL NEEDED FOR A FULL LESSON ON SPONGES.

1 Sponge in alcohol (section)

2 Skeleton of Horny Sponge.

3 25 sections of Horny Sponge.

4 Model of section of sponge, showing cilia cells etc.

5 Tube Sponge with dried flesh.

6 Slide for microscope, showing portion of horny fiber of Tube Sponge, illustrating tubular structure and arrested growths of fiber branches.

7 Logger-head Sponge.

8 Net Sponge.

9 Cord Sponge.

10 Slide with spicules of Marine Spiculigenous Sponge.

11 25 sections of Spiculigenous Sponge.

12 25 sections of Finger Sponge to show water system.

13 Section of Gray Cup Sponge.

14 Green Cup Sponge.

15 Purple Sponge.

16 Section of Creeping Sponge.

17 Northern Branching Sponge.
18 Fresh Water Sponge, dry.
19 Slide showing ova case of Fresh Water Sponge.
20 Slide showing spicules of Fresh Water Sponge.
21 Limy Sponge.
22 25 sections of Limy Sponge.
23 Fleshy Sponge in alcohol.

We can furnish the 23 examples given above, including 25 specimens each of Nos. 3, 11, 12, and 22, neatly put up in boxes for $8.00 net.

We can furnish an epitome of the above collection for the use of lower grades of schools, or for a brief lesson on sponges in higher grades, omitting the 25 specimens mentioned under Nos. 3, 11, 12, and 22, and Nos. 6, 10, 19, 20, this giving 14 specimens in all, also put up in boxes for $2.50 net.

Address,

C. J. Maynard,
447 Crafts St.,
West Newton, Mass.

COLLECTING AND PREPARING SPONGES FOR SCIENTIFIC USE.

The following are the methods which long experience has taught me are the best for preparing sponges for scientific specimens. To begin with one of the most important items, by whatever method sponges are prepared, they should always be carefully labeled, giving locality, date, depth of water, character of bottom and color when living. Notes should also be made as to whether the sponge shrinks upon being handled, its general appearance under water, whether the large excurrent tubes are open or closed, and in this connection it is well to note the state of the tide in collecting marine species, whether ebbing or flowing. Any other notes in respect to the situation of the sponge upon the bottom regarding currents etc., position in which the sponge grows upon any object; in short, almost any notes which can be made upon animals which are so little known living as are the sponges, will prove of value.

COLLECTING MARINE SPONGES.

For gathering many Marine Sponges, the collector will need a water glass and sponge hook, which instruments are described on pages 51 and 52, also a boat. As related, it will require considerable practice to gather sponges in swift tide ways. When gathered, sponges should not be placed together, but should be kept in separate jars or other vessels in water. This is easily accomplished when in a boat, hence it is always advisable to have one for convenience in carrying instruments and specimens, even when one is wading along shallow banks upon which sponges abound. When it is possible it is best to try and remove a sponge from the bottom with the hands, which may be guarded from the unpleasant effects produced by the spicules of those species which are thus armed, by the use of rubber gloves. When the object upon which the sponge grows is small enough to be removed with the sponge adhering to it, it is of course best to let the sponge remain on its natural base.

When a sponge adheres too firmly to the bottom to be removed with the hands when wading, it is best to cut it away with a knife, taking care to cut as near the base as possible.

DRYING MARINE SPONGES.

As soon as possible after sponges are dead they should be dried. In preparing specimens in which the color can be retained, it is best to dry them in a warm place, but not directly in the rays of the sun. I have been most successful in preserving the color of sponges by placing them on boards or rocks in the sun, but covered with papers. Small sponges should be dried about a half a day on one side, then turned and dried on the other side. A sunny day will be sufficient to dry such sponges when they can be wrapped in tissue paper and placed in boxes, but such boxes should be kept in a warm, dry place. Large specimens must be kept longer in the sun.

All sponges which blacken like the Commercial Sponges, Tube Sponge, or Giant Cup Sponge, upon exposure to the sun, or which do not change color like the Loggerhead Sponge, are best exposed to the full rays of the sun, but they must be placed on rocks or boards and turned. All moist specimens dry best when placed in shelter or covered with canvas at night. Do not keep sponges packed in wooden boxes for shipment for any length of time. They are almost sure to gather moisture, then soften and mould, although if they are dipped in a 5 per cent solution of formalin before drying, this moulding may be prevented in a great measure.

Branching Sponges and fragile specimens with filaments should be fastened to the bottom of shallow pasteboard boxes before they are quite dry, then the boxes placed in a warm, dry room.

ALCOHOLIC SPECIMENS OF MARINE SPONGES.

Sponges will shrink less when placed in alcohol if allowed to die in salt water, which gradually grows warm by exposure to the sun. When once dead, however, the specimen must be at once removed from the water and placed in a 50 per cent solution of alcohol in which it must remain for 24 hours, then placed in a 95 per cent solution, where it may be kept permanently, unless the alcohol becomes stained with fluids emitted by the sponge, in which case, the alcohol should be changed as often as the staining occurs.

Formalin cannot as yet be used successfully in preserving sponges, but further experiments with it may prove satisfactory.

Small sponges for biological and histological work may be placed in a saturated solution of picric acid from which they must be removed in twenty-four hours, and placed in alcohol which must be changed as long as it becomes stained.

Sponges so treated may be embedded in paraffine, sectionized and mounted, or stained and mounted for microscope slides.

PREPARING SKELETONS OF SPONGES.

It is best to prepare skeletons of sponges from fresh specimens. The dead sponge is placed in water in a closed vessel where it is allowed to remain from forty-eight hours to a week or more, depending upon the species; it may then be removed with long forceps and carefully washed in salt or fresh water.

Sponge fiber from such specimens may be mounted for microscopical study in balsam or glycerine, or the arrangement of the fiber may be studied with a good magnifying glass.

Avoid squeezing specimens which are intended for microscopical study. It is best to let the water drain out of them. Sponges which have been dried with the flesh on can be macerated, but the process is more difficult, and potash must frequently be used to facilitate removing the hardened flesh.

Both fiber and spicules should be boiled before attempting to mount them upon microscope slides, in order to remove all traces of impur ites.

COLLECTING FRESH WATER SPONGES.

In collecting Fresh Water Sponges, it will be found convenient to employ a net in which the outer side of the hoop, which should be very strong, is flattened and straightened and can thus be used as a scraper. With this instrument, sponges can be readily lifted out of the water.

When collected, they should be kept in separate tin boxes or glass jars. Although Fresh Water Sponges may be dried, they then lose much of their characteristic form and, especially the small branching forms, are best kept in alcohol.

In preserving in alcohol, they should first be allowed to drain a little while, then placed in 95 per cent of alcohol which must be changed in twenty-four hours, and again if the liquid becomes turbid until it remains clear.

Fleshy Sponges must be placed in alcohol or in formalin, which I found forms an excellent preservative for this class of sponges. Those which I put into a five per cent solution of formalin last winter (1897) have kept perfectly well, their tissues remaining hard.

MAKING CASTS OF LIVING SPONGES.

There is no class of animals with which I have had any experience which are more difficult to make casts of, than Living Sponges. On account of the water which they contain, and which cannot be removed from their tissues without distroying the sponge, neither plaster nor the glue preparation can be used as material for moulds.

There is, however, fortunately a substance which answers the purpose admirably. This is wax, and paraffine wax is what I have used most successfully.

I place the sponge in a tight box (pasteboard will do) which is a little large for it, leaving at least half an inch around the sponge. The sponge must be fastened to the bottom of the box, which can be accomplished by using pins or wire, or it will float in the wax. Melted wax is now poured on the sponge until the box is filled, covering the sponge about an inch in depth. This wax must not be too hot, but still in a sufficiently liquid condition to flow into every minute orifice. It must feel very hot to the finger, but not hot enough to scald the flesh.

When covered, the mould is set one side to cool, which is a rather slow process, varying greatly with the surrounding temperature. When thoroughly cold and hard the bottom of the box is removed, cut away with a sharp knife ; the sponge may now be pulled forcibly out of the mould, for it yields sufficiently to enable this to be done quite readily.

The mould is now wiped carefully out, or in case of delicate sponges, which have long filaments, the water that remains is shaken out, the cream plaster poured in and allowed to harden, which will occur in about a half an hour. The wax mould containing its cast is now placed in the melting kettle, over a fire and the wax heated until it boils, when the cast can be removed.

The cast is colored from another specimen of the same species of sponge, or from a colored drawing of the original of the cast, but oil colors must be used, as the cast has absorbed wax, which will not take water colors readily. The casts which I have made in this way have been exceedingly satisfactory. Duplicates are made with the regular glue and glycerine moulds.

Explanation of Plate I.

Tube Sponge. Verongia fistularis, from the Bahamas, color of dried specimen, reduced size.

PLATE I.

Explanation of Plate II.

Tube Sponge, *Verongia fistularis*, from the Bahamas, color of life. Reduced size.

PLATE II.

Explanation of Plate III.

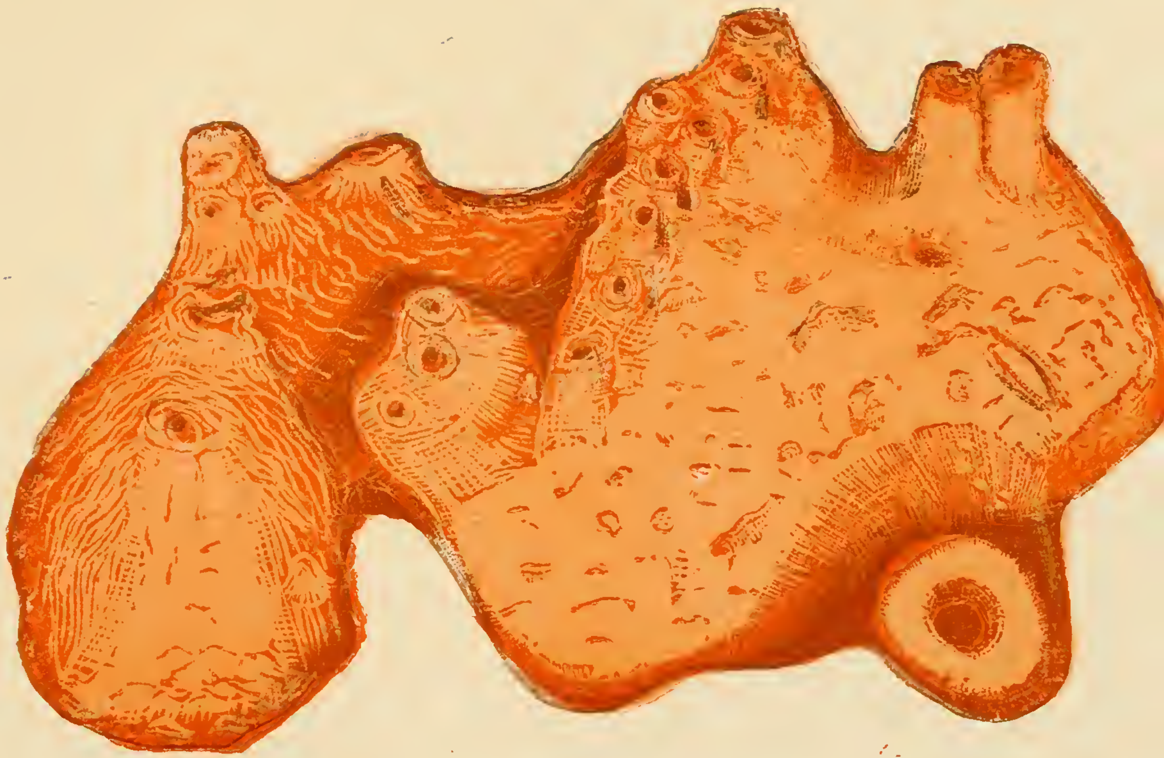
Green Incrusting Sponge. Terpios fugax, from the Bahamas, growing upon a dead specimen of Forking Coral, Porites furcata. Color and size of life.

PLATE III.

Explanation of Plate IV.

Scarlet Sponge, Amphimedon variabilis, from the Bahamas, color and size of life.

PLATE IV.



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