be none the worse; but suddenly the spines began to become depressed in a disorderly manner, while irritability ceased immediately and entirely. If the dose were not quite strong enough, or the exposure not prolonged enough to cause death, there was nevertheless a permanent weakening of the animals produced; for next day they were found to be but slightly mobile, scarcely at all responsive to stimulation, and not adhering to the tank.

Observations on the Madreporarian Family—the Fungidæ, with especial reference to the Hard Structures. By Prof. P. Martin Duncan, M.B. Lond., F.R.S., &c.

[Read January 18, 1883.]

(Plates V.–VI.)

Part I. The History of the Classification of the Fungidæ, and remarks on the Diagnosis.—Remarks on the absence of satisfactory descriptions and delineations of the Synapticula and the resulting confusion.—A description of the Hard parts of *Fungia scutaria* (variety), Lmk., general and microscopical.—Considerations regarding Growth and the Nature of the Interseptal Loculi.

The family of Aporose Madreporaria called the Fungidæ was established by Dana in 1846 in his Report on the Zoophytes of the Wilkes Exploring Expedition. He defined several genera, and gave beautiful illustrations of the general configuration of species, noticing moreover the tentacular arrangement.

In 1849 MM. Milne-Edwards and Jules Haime published a monograph on the family in the 'Annales des Sciences Naturelles,' sér. 3, tom. xv.; and, dealing rather with the hard parts than with the soft dermal tissues, they consolidated the knowledge given by Dana, and discovered some new and family peculiarities and deficiencies. They had the advantage of studying large collections of recent and fossil Fungidæ; and they saw the necessity of founding their classification on data derived both from ancient as well as modern species.

In 1860 the great work by these authors, 'L'Histoire naturelle de Coralliaires,' reached the third volume, and the Fungidæ were very carefully described and classified. They differentiated the family, explained most clearly its position in relation to the Aporosa and Perforata, and divided it into subfamilies.

This work has remained, up till lately, the recognized authority

on the Fungidæ; and during twenty years very few alterations have been made in the classification. Some genera have been added, and some, like *Palæocyclus*, have been expunged; but no extension of knowledge regarding the soft or the hard structures has been recorded. Lately, however, a remarkable diversity of opinion has been expressed upon the value of one of the fundamental and family characters; and the result has been that certain palæontologists, who do not care to study recent forms, have attempted not only to separate the family from the Aporosa, but to deny the classificatory value of the structures called synapticula by MM. Milne-Edwards and Jules Haime.

I believe that these diversities of opinion are due to the want of a knowledge of the writings of the distinguished French zoophytologists in the first instance, and also to the deficiency of accurate details and definitions regarding those internal hard parts of the Fungidæ which are of primary classificatory importance.

Several modifications of the classification adopted by MM. Milne-Edwards and Jules Haime have been proposed of late years, not so much, however, from the influence of the discovery of new structures or of new views regarding the importance of old and well-known ones, as from the desire to replace the generic terms employed before the authors of 'L'Histoire naturelle des Coralliaires' wrote*. The principal change is to give the family Fungidæ the dignity of a suborder.

The classification of the group will be noticed in a future communication; but it is necessary to remember that the Fungidæ cannot be dealt with without reference to the other divisions of the Madreporaria, which is a suborder of Zoantharia. The order Zoantharia has clearly three groups in it—the Malacodermata or Actinaria, the Sclerobasica or Antipatharia, and the Sclerodermata or Madreporaria. These are very distinct suborders. They cannot be promoted to orders, as the Zoantharia are not sufficiently differentiated from others to be worthy of the position of a class. There are two groups of the Madreporaria, the Aporosa and Perforata, and the Fungidæ link them together. But the first-named groups, in consequence of the natural grouping of sets of genera in them, must be subdivided into families and subfamilies. Hence the Aporosa and Perforata are sections or

* Especially Verrill; and Klunzinger, 'Korallenthiere des Rothen Meeres,' 1879.

primary groups of Madreporaria comprising families. The Fungidæ (with their synonyms of *Fungacea*, Verrill, and *Fungiacea*, Klunzinger) have not the same zoological significance as the groups just mentioned, and cannot be placed except as a family divisible into subfamilies and genera.

Since Dana established the family Fungidæ, some fossil and recent genera which had been classified with the Aporosa have been admitted into it; but that affords no reason for an alteration of name. Moseley retains the recognized position of the Fungidæ, and so did M. de Pourtalés.

The Fungidæ as differentiated by MM. Milne-Edwards *and* Jules Haime *.—"One of the general and most striking characteristics of the species which form this family is the short and expanded growth of the corallum, whether it increases by gemmation and becomes a compound form, or whether it remains a simple one. But this tendency to a more or less horizontal development of shape is not invariable and absolute; and by itself it could not afford a satisfactory differentiation of the type, were this external character not associated with an internal structure of a very great importance. We have already seen that the interseptal loculi are either vacant down to their bases in such groups as the Turbinolidæ and Dasmidæ; or are closed at certain heights by lamellar dissepiments, as in the Oculinidæ, and principally in the Astræidæ."

"The Fungidæ present a new disposition in the structure of their interseptal loculi, which is not found in other groups. *The dissepimental tissue is completely deficient in their interseptal loculi* as in the Turbinolidæ; but the dermal sclerenchyma of the sides of the septa becomes developed in places and extends beyond the septal laminæ, *forming projections like warts or tubercles, which grow towards those of the opposite sides of the next septum and fuse.* It follows that the interseptal loculi and the visceral cavity in that position are more or less traversed, but never completely closed, by kinds of bars often of considerable dimensions. This interseptal structure differs greatly from the endothecal structure of the Astræidæ, both in its nature and analogies. We may consider the structures forming it to be analogous to extremely developed granules such as are seen in most of the septa of the Turbinolidæ, Astræidæ, and Madreporidæ. These transversely placed organs, which we have proposed

* Hist. Nat. des Corall. vol. iii. p. 1 *et seq.*

to term *synapticula*, vary a little in their shape. Usually, and we believe it is the case in all the species of the subfamily Funginæ and in most of the subfamily Lophoserinæ, where contiguous septa are forced apart, well-marked ridges placed vertically or slightly obliquely, and composed of compact sclerenchyma, are seen on the two ruptured faces. They are usually smaller in breadth here and there, or may be interrupted and separated off into series. In such genera as *Trochoseris* and *Psammoseris* these vertical rows of synapticula are made up of small bars, few in number, and they are only found low down in the interseptal loculi. But here the tendency to an appendicular growth on the faces of the septa is seen by the presence of numerous and projecting cylindro-conical and subspiniform granules.

"The synapticula appear to have escaped the notice of previous observers; and even Dana, in his beautiful illustrations in the Atlas of his great work on the Zoophytes, does not notice them in the Funginæ, and only just indicates them in some Lophoserinæ.

"In simple forms of Fungidæ the calices are usually superficial and turned down at the sides; and they are always imperfectly circumscribed in the compound forms. These increase by lateral gemmation and not by fissiparity.

"The septa, or the septocostal rays, are made up of perfect laminæ, or *they may be feebly perforate*; their free edge is invariably dentate or echinulate.

"The corallum being disciform or foliaceous, the 'walls' occupy the base of the individual, and the sclerenchymatous laminæ which constitute them are often entire and continuous; but in many other instances these laminæ are more or less perforated.

"The Fungidæ, whilst being naturally classified amongst the Aporosa, show a very clear indication of a passage into the Madreporaria perforata, which may be well seen in *Anabacia* and *Genabacia*. Moreover, the Fungidæ are readily distinguished from the preceding groups (all the other Aporosa) by the presence of synapticula; whilst their usual shape allies them with the Echinoporinæ and Merulinæ.

"The family Fungidæ is divided into two subfamilies, which are differentiated as follows:—

"The *Funginæ*, which have a disk or mural plateau without epitheca, and which is usually strongly echinulate and always more or less porous.

"The *Lophoserinæ*, in which the wall or common plateau is neither echinulate nor perforate" *.

Remarks on the Diagnosis of the Family.—Nothing can be more explicit than the family characters of the Fungidæ as established by MM. Milne-Edwards and Jules Haime; yet it is perfectly evident that they have been neglected and misinterpreted during most of the discussions which have taken place regarding the systematic position of some of the genera of Astræidæ and Fungidæ. It is manifest that in no work on the Invertebrata is there a clear and definite explanation given of what synapticula really are, in shape and method of development. The general belief is that they are large ordinary granules which meet, and thus unite together the septal laminæ on either side of an interseptal loculus, thus forming cross-bar structure. Usually it is credited that these large granules are hypertrophied ornamental granules. In fact there is no accurate description, and only one delineation of typical synapticula, in any modern work with which I am acquainted, and which treats of the general anatomy of corals.

A delineation is to be found in the last work of my lamented friend M. de Pourtalés, but unfortunately no description accompanies it. It is in the 'Report on the Florida Reefs' by Louis Agassiz, accompanied by illustrations of Florida Corals, 1880, plate xv. figs. 14 & 16. The vertical synapticula are admirably shown in fig. 14; and the well-known appearance from above, a very misleading one, is shown in figs 15 and 17.

In spite of the descriptions and delineation, it is now asserted, mainly, however, by the students of Oolitic fossil corals, that the importance and classificatory value of the synapticula is not thought to be what it was.

Nature of the Sclerenchyma of the Species of the Genus Fungia, *subfamily* Funginæ.—The shape of the Fungias and their general aspect are so well known, that it is only necessary to remark that they are not attached, have a slightly or greatly arched base, and are convex above. They may be circular or elliptical; and there is an axial fossa which is elongate in the forms with an elliptical outline. The septa are very numerous, usually large and small in succession, and the free edge is variously dentated, spined, or nearly plain.

When one of these corals is looked at from above, in its natural

* Milne-Edwards and Jules Haime, *op. cit.* vol. iii. p. 4.

position, large septa are seen radiating from the axial space to the circumference, and between them are medium-sized ones and also some very thin and extremely delicate-looking septa. The interloculi are the spaces between the septa, and which in true corals are occupied by mesenteric folds during life, and they are now seen to be empty for some little distance from the axial space and also in their upper portions. Lower down, however, and on a level with the top of the thin intermediate septum is (in every interseptal loculus) a series of structures which join the sides of approximate septa together. As each septum, of whatever size it may be, has a row of these synapticula along its sides from within outwards (from axial space to circumference), a very peculiar appearance is given to the coral, and one which has been correctly drawn by Pourtales and Klunzinger*. Each synapticulum is stout, broad from side to side, nipped in and short from within outwards. There are about eight or nine of them, with spaces separating them, elliptical in outline, in a centimetre. What is seen are the tops of the synapticula.

These cross growths are solid-looking, and they are nearly subequal, so that a very thin and leaf-like septum has great joining-structures on its sides, which are as large as those which are seen on the flanks of great primary septa. Very often the synapticula are attached to a large septum and only partly so to a very thin septum, a portion of some synapticula remaining free.

Besides these large synapticula, a very few smaller ones are seen, which may or may not reach across the interseptal space from one septum to its neighbour.

Moreover, where the very delicate septa overlap those between them their tissue is finely trabeculate.

The ornamentation of the sides of the septa is of small granules, which increase, in the form chosen as the example, in size towards the axial space of the coral; but the synapticula and the more or less imperfect growths just alluded to are independent of and *are not modified granular ornamentation.* Not a trace of dissepimental tissue stretching across the interseptal spaces and closing them is to be seen, and it does not exist in the Fungidæ proper.

When a specimen is carefully fractured across, at right angles

* The synapticular series are not visible from above near the axial fossa, but become so further out.

to the elongate central fossula and parallel with some of the large septa, the synapticula of the implicated interseptal loculi are broken across and rendered visible in their whole vertical height. They can be seen in their relation to the large and small septa. On the sides of the large septa they appear as long narrow continuous ridges separated by grooves, and having a slightly curved direction, but being in the main vertical. Starting from the flank of a large septum at some distance below its free edge, the synapticula pass downwards to the top of the dense basal wall. They may be nearly straight in vertical direction in some parts; slightly curved, concavity inwards, and often looking slightly upwards or downwards in others. Towards the outer part of the septum, and near the circumference of the coral, the curving of the synapticula, which are shorter there, is more decided than elsewhere, and the concavity is directed upwards and inwards. Near the axial space the synapticula are short in vertical measurement and curved, concavity inwards.

So that along an interseptal loculus a succession of vertical and curved ridges, one close behind the other, extends from close to the axial space to the circumference.

The extreme vertical length of the synapticula varies in the genus; and in the species under consideration it is 11 millim., and the thickness, calculated from the direction of the axis to circumference, is ·5 millim.; and forty is an extreme number of ridges to find in succession.

In a few places the vertical ridge is discontinuous, and in others the ridges may be wavy in their vertical course.

The ridges are of course synapticula broken across; and there is a groove between each successive pair, very equal in height and length from within outwards. So that a series of ridges and furrows covers the septa at a certain distance from their free edge down to the base.

On approaching the fractured surfaces and those joining the ridges together, it becomes evident that each interseptal or interlocular space is open above between the upper parts of the septa, and that below it is subdivided into numerous canal-shaped spaces, each being bounded inwards and outwards by synapticula, and on either side by septa. There is an open space also near the axis, and this is bounded externally by the first synapticulum.

The synapticula which are attached to the thin and smaller septa arise close to their free upper edge; and in all other

respects resemble those of the large septa. There is a remarkable contrast between the stoutness and solidity of the synapticula and the delicacy, thinness, and often perforate and fenestrate condition of the higher orders of septa.

The smallest septa are nearly transparent, and consist of a more solid portion, which is in contact with the synapticular ridges, and of a perforated and thin portion, which corresponds with the interridge, groove, or canal. The perforations open into the canals; and thus there are more or less vertical and slightly curved alternate rows of foramina and solid structure. High up in the thin septa, and just beyond the top of the synapticula, the close part of their structure sometimes becomes almost rod-like, and broad processes arch from it on either side over foramina in the perforated portion.

Remains of this arrangement can be detected on the free edges of the larger septa, and vertical lines with curved ones between them, indicated by a denser molecular arrangement of the carbonate of lime, are to be seen on worn edges. It is evident that the fenestrate condition of the smallest septa is not permanent, and is due to incomplete development.

A tangential section across the coral near the circumference shows septa, of all sizes united by synapticula, the basal wall also a synapticulate structure, and the costæ below. As the section is vertical and the direction of the synapticula is more or less curved, they are found cut obliquely in some places, through a considerable height in others, and fairly across in many spots.

The large septa increase in width downwards to where the synapticula arise, and then diminish to the wall; and their relation to a very slender perforated septum on either size is seen to be through the medium of short stout synapticula. At the basal wall there are transverse views of large and small septa; and it is evident that, here and there, the wall is deficient, leaving spaces corresponding with the openings which may be seen on the underside of the coral between the costæ. The costæ are continuous with the septa below the wall. Now the section indicates that the wall is composed of more or less horizontal or curved synapticula, thicker than others, above; and where they are wanting, there is an opening leading upwards into an interseptal loculus, but bounded by the synapticulum above. The opening leads to a canal, and by it to the free part of the loculus. The openings are found near the circumference of the

base, relate to the incoming of new septa, and fill up with age. Here and there the costæ are united by a synapticulum which stretches across from the flank of one to its next neighbour. Finally, the minute spinulose ornamentation of the sides of the septa is seen between the synapticula; and it is evident that they are different things.

Remarks on the Distribution of the Septa.—The thinnest and smallest septa (on either side of the medium septum in alternate large interseptal loculi) overtop those between them, and arch over them in the form of a finely trabeculate tissue in some places. And midway towards the axial space these more delicate septa unite to form a thick one, and this in its turn unites nearer the axis with another one formed in the same fashion. It is near those junctions that delicate trabeculæ cross the spaces between the smaller septa and act as synapticula. The thickening near the upper part of the synapticular ridges is seen in the smaller as well as in the larger septa.

If two of the thickest and tallest septa which are nearest each other at the axial space be considered limits of a system, there will be a large and slightly smaller one between them at the axis. There are primary interloculi between them. There are three very small septa in such an interloculus—that is, between each large septum and the smaller median one; and they reach, after uniting as one, close to the axial space.

The three larger septa do not have others joining them; and they pass to the margin, diverging considerably so as to admit of the origin and junction of many smaller septa; and these increase in size towards the margin according to their age or origin near the axial space. The three septa in each primary interseptal loculus reach the margin as thick ones; and so many are added towards and in the outer half of the coral between the two large septa, that no less than forty can be counted there.

The larger septa project beyond the smaller at the margin of the corallum; and every septum is continuous with a costal ridge which is denticulate, except in the instance of the very short costæ of the latest and minutest septa. About thirty large septa reach the axial space which they bound.

The young septa originate between the next older ones, or between a next older one and a much older one. They commence at the base; and it appears that synapticula are formed either prior to or simultaneously with the septum, for they and

it contribute to the basal wall before the septum has increased much in height.

The additions of new septa are made with growth of the coral more and more remotely from the axis; and they are possible because of the divergence of the radially disposed larger septa.

The Columella.—The columella is composed of lax trabeculæ crowded together; and it is a very low structure at the bottom of the axial space. No additional structures are given to it by the septa, and it rests upon a thick part of the wall; and probably it is really the only part of the base which has not a synapticular origin.

The Interlocular Spaces.—It is evident that the spaces in which the soft parts are contained are very restricted. There is the axial space bounded below by the columella, and it extends between the septa only for a short distance. It is bounded up to a certain height by synapticular ridges. Above the limits of the ridges there are the interseptal loculi, whose base is at the level of the upper synapticula. But the loculi are continued to the base of the corallum along the canals formed by contiguous synapticular ridges and the septa they join together.

The interseptal loculi are therefore not closed below perfectly; but this open condition is slight, and is diminished or destroyed by growth.

One might speculate upon the impossibility of the occurrence of mesenteries, and wonder whether these forms are really corals.

It is extremely probable that the peculiar shape of the base of the Fungidæ relates to this communication between the visceral cavity and the outside*.

Histology of Hard Parts.—The microscopic appearances of this *Fungia*, in sections tangential to the septa, and which necessarily include large and small septa and synapticula, denote that, whilst some synapticula are continuous with the septal structure, others are not and are independent. When the section is rubbed down thin enough for the employment of an object-glass of 300 diameters, the septa show multitudes of dull and light

* The species of *Fungia* examined and described here is a variety of *Fungia scutaria*, Lamk., from the Red Sea and Indian Ocean. It departs from the type in the extreme minuteness of the ornamentation, the great number of septa (although this may be accounted for by growth), and the larger spines on the base. It seems to connect *Fungia paumotensis*, Stutchbury, and *F. scutaria*, both of them being members of the artificial group of genera classified by Milne-Edwards and Jules Haime as *Fungiæ subintegræ* (*op. cit.* vol. iii. p. 16).

markings, which radiate from the inner part to the sides, or from side to side, ascending obliquely and curving gradually to the edge. In some instances there is no limitation of this radiating structure at the synapticulum, the texture of which is evidently continuous with that of the septum. But in the majority of instances a dark line of separation exists at a short distance from the septal edge, and which marks off the synapticulum. The radiating fibrous-looking structure of the septum stops at this dark line. On the other hand, the fibrous appearance of the synapticulum is in a direction more or less at right angles to that of the septum; so that the dark line is bounded on one side by septal or on the other by synapticular fibrous-looking structures, which impinge on it at different angles.

Opposite to the fixture of the synapticulum to the large septum is its broad face of attachment to a thin septum of a high order; and the structures of the synapticulum are independent of, and not continuous with, the tissue of the small septum. Very commonly the thin septa break off from the synapticulum and leave it with a perfectly plane surface.

In some instances a synapticulum is marked with a line of division in its midst, midway between the septa on either side; and then one half participates in the peculiar structures of its septum, which are continued into it in the same direction.

In this last instance the synapticulum is a growth from the septum, and is continuous with it; but in the former it is an independent body joined on to two septa.

The synapticula are often grooved vertically, so as to enlarge the lumen of the canal which they help to form; and they increase beyond the normal dimensions towards the base, and unite in a homogeneous mass composing the basal wall.

The synapticula are not hypertrophied granulations, from which they differ in shape, position, and structure.

The microscopical structure of the synapticula is the same as that of the larger septa. Very thin sections show long, fusiform, very narrow fibres placed side by side, or prisms with a base and a very long body, or with a short and rapidly tapering body. In some the larger end is rounded. Certain markings are seen by transmitted light which are across the course of the fibres; but before considering their course or nature, it is necessary to remember that the fibres in a septum do not run in parallel and superimposed layers everywhere. On the contrary, there is much

local and general radiation from the median line of the septum or from one edge. Moreover, these fibres are of different lengths. Hence where the fibres are not mostly fusiform, but have rounded ends or geometrically shaped terminations, they will act differently on light during its transmission through parallel planes and radiating series of them.

The common appearance is of excessively minute dark cross markings, which, under a high power and careful illumination, resolve themselves into more or less circular rings placed nearly in little linear series. The rings are dark, and have a light central part. And it appears to me that these markings are caused by the shape of the larger ends of the fibres below or above those in focus.

The thinner septa, which are so constantly seen perforated and ending above in a wave-like edge, explain the construction of the hard parts better than the sections of the larger septa. Thin septa are so delicate at the free edge, that they may be examined successfully when mounted in balsam without rubbing down previously.

The direction of the fibrous structure is exceedingly irregular; and it does not appear that there are definite vertical sets of fusiform bodies with offshoots here and there forming the sides surrounding the vacuities. There is nothing resembling microscopically the lattice-work structure seen with a low power in *Porites*, for instance, amongst the Perforate corals. But near the free edge of the thin septa the fusiform bodies and long tapering prisms project with a sharp end outwards, and are placed side by side and in series of planes one over the other. A little lower down these microscopic elements become oblique, and those on one side of a line which corresponds with the apex of a dentation on the free edge of the septum converge towards those on the other side, a vandyke or herring-bone appearance being given. Polarized light is a great assistance in this research.

In the thin portions of the youngest septa where there are fenestrations, the fibrous element does not radiate from or to them from denser parts of the septum. In many places the fibres surround, and have their long axes parallel with, the curves of the periphery of the openings; but here and there a dark line or lines which pursue an irregular, yet on the whole radiating, course from an opening have the fibres converging to them obliquely. On employing as high a magnifying-power as the section

or simply mounted septum will permit, it becomes evident that the dark lines thus observed in the neighbourhood of the opening resemble those along the septa, and which end at the apex of a dentation, and others which assume a radiating appearance in the larger septa. These lines are the spaces between the fibrous elements of the hard parts in those particular spots filled with connective tissue or its remains. This need not be mistaken for tubes of *Achlya penetrans*, which are, however, seen here and there in every section of the coral.

The breadth of the fibres, which behave more like arragonite than calcite under the polarizer, is about $\frac{1}{4000}$ inch.

It would appear that the fibres of the carbonate of lime are deposited, like those of other corals, in a connective tissue, and that layer after layer is formed with more or less obliquity here and there, but not everywhere. The septa, so exceedingly delicate and porose when young, enlarge by deposit on their faces, and the perforations gradually become closed up. And it is evident that the large synapticula which are in contact with these thin septa originate irrespectively of them, and are not at first attached to them except by the medium of soft tissues. Deposit of fibrous structure occurs subsequently, and then union takes place.

The examination of this species shows that the great length and breadth of the synapticula and their forming boundaries of canals renders them only of secondary importance to the septa; and as the basal wall is composed of fused synapticula, there is no value in the observation that these structures are of little classificatory value.

Part II. The Construction of the Corallum of *Fungia echinata*, Ehr. sp.

Fungia echinata, *Ehrenberg* sp.—Haliglossa echinata, *Ehr.*—Fungia Ehrenbergi, *Dana.*—Herpetolithus Ehrenbergi, *Leuckart.*

That this remarkably elongate and echinulate form of *Fungia* should have three generic names given to it, is explanatory of the difficulty of classifying the species on account of its departing somewhat from the generic idea of *Fungia.*

The form differs from the rest of the *Fungiæ* mainly in its length in relation to breadth. In this the species resembles *Herpolitha* (*Herpetolithus*); but it is not a sufficient reason for separating it from the genus *Fungia*, especially as the species of *Fungia* already noticed in this communication is somewhat elon-

gate. But it is evident that there is another character, which relates to the long axial fossa. MM. Milne-Edwards and Jules Haime write:—"La fossette centrale est extrêmement longue, étroite et peu profonde;"* but they do not notice that there are any rudimentary calyces along its path. Yet in the specimen now under consideration, from the Indian seas, the continuity of the fossa or axial space is interfered with by the junction across it of a large and small septum and of the rising upwards there on the median line of the columella. In fact there is such an indefinite calice in one half of the coral as may be seen in numbers along the axial space or fossa of *Herpolitha*. A corresponding structure may have been seen by Leuckart, who placed the species in that genus. Klunzinger relegates the species to the genus *Haliglossa* of Ehrenberg.

The calices seen on either side of the axial space in *Herpolitha* are not found in this species; and it must be considered a connecting form which should be placed last in the genus *Fungia* and next to *Herpolitha*.

There would be no objection to making *Haliglossa* a subgenus of *Fungia*, its character being the elongate shape and the discontinuous axial space; but I am not certain that an undeveloped calice is invariably absent in all *Fungiæ*, or present in all the specimens of *Fungia echinata*. My impression is that it is not an invariable character; and considering the singular powers of perception and the great correctness of Jules Haime, it is very probable that there was no such calice in the type described by MM. Milne-Edwards and himself. Under the circumstances, I retain the form in the genus *Fungia*.

There are some very interesting points about the anatomy of the hard parts of this coral, especially in relation to the structure of the septa and the synapticula.

On looking at the coral from above, the succession of septa is one thick septum with large dentations which are even dentate on their edges, followed by three small thin ones, of which the middle septum is slightly the thickest. The middle septum has its free edge lower than that of the large one, and it is also dentate in a minor degree; and the thin septa on both sides of it are still lower in the interseptal loculi, and have their free edges incised or very broadly and lowly dentated.

* *Op. cit.* vol. iii. p. 14.

As in the *Fungia* already noticed, there are several instances of minor septa uniting within (towards the axial space) or beyond the next largest.

Unlike the other species of *Fungia*, this form does not exhibit the rows of large synapticula separated by spaces when seen from above; and even a fracture at the side of the corallum, which removed the outer parts of the septa and exposed the interseptal loculi to some depth, only gave faint indications of their presence. Moreover, although so greatly ornamented at the free edges, the septa are comparatively free from granules on their sides low down; they are sparingly distributed in such situations on the larger septa, and very sparingly on the middle-sized ones. Higher up, and for some distance below the dentations of the larger septa, the granules often run together and form a vandyke pattern, angle upwards; and when they remain separate they assume the same shape in a series, and are large and low, especially near the inner ends of the great septa.

A transverse fracture enables the structure of the septa, synapticula, and basal wall to be seen, with granular costal spines on the base. It shows also the remarkable shape of the corallum, which has, in the specimen now under consideration, a crescentiform transverse section, and that the direction of the tall synapticula of the inner half is nearly vertical, for they do not radiate from the base. Further out and near the circumference the synapticula are more or less radial from the imaginary centre of the curve of the transverse section; but their height is small, and they are decidedly curved and often discontinuous; that is, the ridge form is deficient here and there, elongate nodules replacing it.

The larger synapticula near the axis are slightly curved and wavy in their direction, and they are slenderer than in *Fungia scutaria*. They form, however, a considerable series separated by spaces which are canals when the coral is unbroken, and their path is oblique to certain lines of depression which are directed upwards and outwards on the septa. These lines correspond with the concavities between the tall dentations, and often become slits and decided foramina, especially near the base in the septa, dividing them into palisade-looking processes.

The higher orders of septa are as cribriform as they are in the other example of *Fungia*; and solid stout synapticula attach them to the neighbouring dense and large septa. The orna-

mentation has not the same direction as the synapticular structures.

A thick base shows openings somewhat rarely; and in some places costæ unequal in breadth, spinulose and granular, are well seen.

The distinctions between this form and that already noticed amongst the *Fungiæ* are the more slender synapticula, their vertical position within and their discontinuous development near the circumference, and the slit-like openings in the course of large septa. It is evident that the morphology of these species of *Fungia* is very similar.

Part III. The Arrangement of the Hard Part of the Genus *Herpolitha* (*Herpetolitha* auct.).

Genus Herpolitha*, *Eschscholtz.*

The corallum is compound, free, long and narrow; the upper surface has indistinct calices of two kinds—one set occupy a long central line and are multilamellar; and the other are placed irregularly, have but few lamellæ, and are small. The septo-costal rays are stout and long and alternately thick and thin; none reach from the axial furrow to the circumference. The base is perforated and echinulated.

The genus may be said to embrace elongate slightly compound Fungias; and the typical species is *Herpolitha limosa*, Esper, described by Edwards and Haime (*op. cit.* vol. iii. p. 24), = *H. foliosa*, Ehrb.

The internal structures of the corallum have been hitherto undescribed, with the exception of a notice of the septa, which Milne-Edwards and Jules Haime thus describe, "leur faces montrent les cannelures verticales granulées" (their faces present vertical granulated flutings).

This is an unfortunate expression; for, taken in relation to the description of synapticula given by those authors in the first part of the diagnosis of the Fungidæ, the flutings, having of course a ridge on either side, may naturally be considered to be rows of synapticula. Indeed everybody who has the common idea of the synapticulum being an exaggerated ornamental granule will be misled, especially as the authors do not mention any synapticula in the generic diagnosis.

* *Herpetolitha* of more modern authors and restored by Klunzinger. See his excellent criticism, *op. cit.* p. 68.

A section of a corallum was made across the length, and the septa were carefully separated. The larger septa are higher than the others, and are marked on their sides (faces) by very regular vertical or slightly oblique, rather close, narrow and low, faint ridges, which carry, at close and regular intervals, distinct sharp granules with a broad base. In some places the ridges are wanting, and the granules exist in regular series all the same. In other places the ridges exist without the granules. Here and there, near the free edge of the septa, a short intermediate ridge is intercalated. The largest granulation is on the larger septa near the axial fossa; and the vertical arrangement is often replaced by an irregular one, or by concentric lines of granules and ridges.

On the outer septo-costæ near the margin of the corallum these lines of ridges and granules run upwards and outwards.

This ornamentation is found upon the thin septa, and upon all septa between the true synapticula, to which it does not present the slightest resemblance. It is a marked feature when seen from above upon the sides of the septa.

The septa are with few exceptions, which occur in the rudimentary calices, alternately large and small; and there is much arching over and joining of certain septa within and without larger ones; and in the greater part of the length of the corallum no septum which reaches the axial space extends to the margin as in *Fungia*. Usually there are three septo-costæ, one within the other, in a line from the axial space to the outer free margin of the corallum. All the septa are whole, and the perforated and immature condition of the thinnest kinds seen in the genus *Fungia* is not represented in *Herpolitha*.

The synapticula, seen from above, are rather close to the free margin of the septa, except in the case of the very large ones; and their size from within outwards is less than the elongate space which separates them from their neighbours within and without. They are numerous, regular, but wanting here and there; their obliquity is evident.

On fracturing a corallum across the length, the synapticula are seen extending from the thick basal wall upwards, in a curved series, on the flanks of the septa. The vertical position is always assumed on certain septa; but, as a rule, these growths are in gentle curves, extending much higher on the small septa than on the large. A synapticulum may extend without interruption down the whole depth of the interseptal loculus; but in the

neighbourhood of the outer part of the corallum, especially, it may be discontinuous, several knobs being in a line and separated by the plain face of the septum. The direction of the curvatures is always with the concavity inwards and never outwards. The breadth of some intersynapticular spaces is greater than others.

There are some interesting modifications of the growth of the synapticula. First, these ridges are seen on the faces of some large septa, where the usual thin small septum in natural succession is partly or wholly absent. The synapticula there are of the usual size, are slightly nipped in and then expanded, and the free edge of the expansion, or that part which should have been in contact with a small septum, is a plane surface. Secondly, near the margin of the corallum the outermost synapticula close to the basal wall are in the form of irregular, broad, and high nodules, a small nodule being here and there.

The first condition indicates that the synapticulum is a growth which may be independent of origin of two opposed septa; and the second explains the continuation of the basal wall by the union of the irregular nodular and wide synapticula and their subsequent radial growth. It is evident that a thin septum may grow up and find synapticula ready for it to impinge upon and join, and that the perforations in the basal wall which usually fill up with age are openings between basal synapticula which enter, however, interseptal loculi. The union of the adjoining septa by the synapticula causes the lower parts of the interseptal loculi to be filled with a series of canals opening above, and a few opening below, as in *Fungia*; but here and there the canals are not perfect, and run one into the other laterally, or rather in an axial or circumferential direction.

Some of the most important points regarding the synapticula of *Herpolitha* are their curvature in relation to different septa, their comparative shortness, and occasional interruption and representation by lines of separate growths. It is interesting to note that these lines are not on or along those of ornamentation. There are no dissepiments in *Herpolitha*.

Where the so-called calices are seen on either side of the central axial series, a condition of the free upper margin of some of their larger septa exists which is remarkable. A separation of the septum appears to be in process, or rather two septa are forming from the old one as their base; and they are united by

very curious small and numerous synapticula, which, however, can be clearly differentiated from ornament.

Finally, the columella is trabecular, and in some places, where large septa come close together, on opposite sides of the axial space, it appears to unite them together. It is partly formed by growths from their joined inner edges, and partly from structures of a trabeculate nature which spring from the original base of the young corallum.

Part IV. The Construction of *Halomitra crustacea*, Rumphius sp.

Genus Halomitra, *Dana*, 1846.—Fungia, *pars*.—Podabacia, *Milne-Edwards & Jules Haime*, 1850.

There are two genera of the Funginæ, according to Milne-Edwards and Jules Haime, which are very closely allied, namely *Podabacia* and *Halomitra*. *Halomitra* was founded by Dana in 1846, and *Podabacia* by Milne-Edwards and Jules Haime in 1850.

Halomitra, a well-defined genus, included a species which had been differently named by Rumphius, Maratti, Lamarck, and most of the writers on Corals before 1824. It is evidently one of the Funginæ, as it has a perforate base; and it departs from the configuration of the species of *Fungia* and *Herpolitha* by being compound, and by not having a long axial space and irregularly placed and rather indefinite calices.

Podabacia includes a species described by Dana and placed under the genus *Pavonia*, Lamk.; yet all the distinctions between the genera *Halomitra* and *Podabacia* are that the solitary species of the last is fixed and not free, has the base finely granular, the granules being sharp and spiny, and the smaller calices are subradiate. So that between it and *Halomitra* with a free corallum, tolerably distinct calices, and large papillæ on the base there is not a generic difference. Both groups have a large calice around which smaller ones are concentrically arranged.

MM. Milne-Edwards and Jules Haime state (*op. cit.* vol. iii. p. 20) that *Halomitra* is "très voisin du précédent (*Podabacia*), dont il ne diffère que par sa forme générale et la liberté de sa base." I therefore unite the genera, and give the name *Halomitra* to the conjoined forms, it having precedence from age.

Halomitra crustacea, a species named *Madrepora crustacea* by Pallas, is the type I have examined; and the specimen came from

Mergui*. The large central (or more or less near the edge) calice is very remarkable, and it does not appear to have been described or figured. It is a deep funnel-shaped or rather elongate calice (2 centim. long), with long septo-costæ, which pass into those of the several small calices which surround it in a ring and extend towards the circumference. The axial space is deep, and at least three times as long as it is broad (length 3 millim.); and its floor is formed by small trabeculæ from the ends of the septa. The septa are nearly horizontal at their upper parts near the edge of the calice, and they then plunge down rather rapidly to the sides of the axial space, which they bound closely. They are well developed, numerous at the outer part of the calice, and in three cycles at the axial space (24). They are distinctly separate (except at their junction parts) in the upper part of the interseptal loculi, which are very visible. The primaries are the largest and have no others united to them; the secondaries are slightly smaller, and also are usually simple and, like the primaries, reach from the margin to the axial space without being joined by any others. The tertiary septa are very compound; they are single at the axial space and bulky there; and they are composed further out of several sets of septa which unite one with the other, and each set is composed of other septa which have coalesced.

In a well-developed system the third septum is thin, straight, and long, and reaches the axial space; it is joined just without on either side by a well-developed septum at an acute angle, and still further out each of these is joined by the junction of three small septa. So that each tertiary septum is composed of an aggregate of seven septa. Hence the septal arrangement of this great calice is of five cycles in six systems. The margins or edges of the septa are profusely ornamented with well-developed dentations, some thick and others thin, and all jagged at their tops and granular at their sides. They are largest on the primary septa. The granular dentations increase in height and breadth, becoming wart-like near the outer ends of the septa and where these merge into those of the surrounding calices. The septa thus ornamented are usually, but not invariably, the higher

* The species is described in the 'Hist. Nat. des Corall.' vol. iii. p. 20; and the notes given above are upon points left unconsidered by Milne-Edwards and Jules Haime.

orders. These dentations are high, with a narrow base and expanded top, and are exceedingly rugged. Ordinarily the higher orders of septa nearer the calicular axial space have a smaller dentation than those on either side*. The slender base and more or less expanded and spinulose or knobbed extremity of the ornamentation are seen in all the dentations of the septa.

Lateral granules are seen, and they cover the flanks of the septa, especially near the free edges; some are on the sides of the dentations, and others, few in number, are on the septa below and between them. They never reach across the interseptal loculi as synapticula.

The septa and synapticula present a very remarkable appearance when viewed from the side, after the removal of a neighbouring septum and separation of the adherent synapticula. These last are large, long vertically, and very solid-looking; but the septa may either be solid and massive, or made up of trabecular processes and perforated. The curved processes forming the trabeculæ are stout, solid, and rounded, and the perforations are spaces between them. There is nothing like a thinning-off of tissue indicative of approaching deposition and filling up of a fenestration. Finally, the dentations on the upper free edge of the septa are on lines of vertical trabecular processes united at the sides; and yet the trabeculæ may join below the base of the dentation and leave a vacuity just beneath it. These vacuities are large and are commonest near the margins or free edges of the septa below the base of the dentations; but larger ones exist deeper down. The trabecular nature of parts of septa interferes with the vertical continuity of the massive synapticula; but where the septa are solid, these cross structures are high, more or less vertical or slightly curved, broad (from septum to septum), and well developed in length from within outwards. They are frequently stouter than the septal trabeculæ, and at other times are slenderer. When perfect, they have long spaces or canals between them similar to those noticed in *Fungia*, and, as in that genus, one canal may communicate with another of the next interseptal space by means of the want of solidity of the septa. When the nature of the septum is trabeculate, the synapticula are either short and restricted to the solid parts where the trabeculæ meet,

* Owing to the refractive qualities of the coral-structure these details are sometimes difficult to see. I find that soaking in a weak solution of carmine tints the white structures and gives excellent results.

or they may be high and continuous, and coincide with the septal tissue by curving here and there, and even giving forth outshoots. In a few places the synapticula are oval in section when seen at the side, small, yet much larger than any granules, and nipped-in midway when seen from above.

The minor calices surround the smaller one in several concentric rows; and the last series has long septo-costæ which reach to the thin edge of the corallum. Most of the calices are distinctly separate in their fossulæ from their fellows of the same circle; but some, whilst free, are only divided from one or both of their neighbours by a single large septum. In a very few instances the large septum does not stretch across, and is divided midway, so that the fossulæ of the calices communicate at the side. These concentric calices are shallow and small, and have six, eight, twelve, or more septa, which resemble those of the large one in their method of junction and of increase of numbers. It is evident that these calices are in organic connexion with the large central one, for its larger septo-costæ are continued into some of the smaller calices which are in their radial path. Moreover this is also the case with the higher orders of septa.

The outermost calices have their septa continued to the margin as alternately large and small and long septo-costæ; and the synapticula joining them are short, curved, and often knob-like.

There is no wall to any calice as there is in the compound corals of the Astræidæ, which separates one from the other, and the only wall is basal and synapticular.

The corallum, as a whole, is thin and consists of a more or less circular lamina fixed below, bulged out correspondingly above, and sloping down all around, and then turned up at the edge.

The under surface is marked indistinctly by radiating costæ, which are most distinct near the edge, where their relation to the septa can be seen. Between the costæ are small, round, and larger slit-like openings rather irregularly placed; and the costæ themselves are shortly granular. As in the genus *Fungia*, the basal openings are produced by defective synapticula.

The columellæ of the smaller calices are flat, and are made up of the ends of septa and are deeply seated.

The upper part of the interseptal loculi is open, and the lower portion is made up of a number of very irregular canals which communicate with each other and with the outside by means of

the basal openings. The canals are less worthy of the name than in the *Fungiæ*, because of the occasional discontinuity of the synapticula.

As might be expected, such a corallum is a prey to parasitic worms, whose thin soft tubes communicate with the upper surface from below, one end being at one of the basal foramina.

The tubes stain readily, and contain spicules; and the coral-structure around has been eroded more or less. Also they have produced abnormal growth of parts of the corallum in the form of cylindrical cavities which open at the surface in the middle of the tops of septa, giving them a hollow appearance.

Part V. Summary.

The examination of species of the genera *Fungia*, *Herpolitha*, and *Halomitra* proves that they are very typical forms of the Fungidæ, and that the last genus links these members of the subfamily Funginæ on to the more trabeculate kinds.

The species have a basal wall which is more or less perforated and costulate; and sections indicate, by means of the microscope, that it is composed of the bases of septa united by synapticula. The openings, which relate partly to the radial growth of the coral, to the formation of new septa, and to imperfect development of synapticula, are frequently closed during growth.

The structures of the sclerenchyma are septa, synapticula, costæ, and a trabecular columella.

The septa are solid in *Herpolitha*, and the larger ones are solid in *Fungia*, except in the palisade-like septa of *Fungia echinata*; but in this genus the higher orders of the septa are incomplete, and irregularly cribriform or fenestrated. This perforate condition does not resemble that of the Madeporaria Perforata; and it becomes modified with age, solidity often ensuing. In *Halomitra* a trabeculate and fenestrate condition prevails.

One of the commonest features of the Fungidæ is the union of smaller septa directly with the flanks of neighbouring ones. This occurs in all the species. In *Fungia* the junction is usually on the flanks, and at the top of the septa as well, and there is a reticulate enlargement where two small lateral septa unite with one between, and which proceeds to the axis as the conjoined septum.

In *Herpolitha* the larger septa never stretch from the median line to the circumference as in *Fungia*, but two or three are in a linear series in the radial direction. Under these conditions the

smaller septa, on either side of the larger, unite into one within and without it, that is to say axially and circumferentially. The union is by a V-shaped mass, more or less dense or merely linear, of delicate reticulate tissue, the transverse parts resembling delicate cross bars. The increase in numbers of septa occurs during the growth of the corallum, which takes place exogenously and at the circumference. As this enlarges, the septa which are radial have increasing breadths between them at the edge of the coral; and in the spaces thus formed septa arise from between septa at the base, and grow upwards, joining the nearest as a rule.

In *Halomitra* the junction of septa is restricted to certain parts of a calicular system; and the third septum of a system is the aggregate of several sets of smaller septa.

Next in importance to the septa are the structures which, besides forming a large part of the base, unite the septa at their sides, and in some instances the costæ also. These are the synapticula. Owing to the introductory statement regarding synapticula by their discoverers, MM. Milne-Edwards and Jules Haime, these structures are treated of by every subsequent author as ornamental granules, wart-shaped projections, and tubercles which stretch across the interseptal spaces, and unite with corresponding structures on the opposite septa, and also as the hypertrophy of the ordinary ornamental granulation of the sides of the septa, fusion taking place at junction.

In the *Funginæ* these structures are only of secondary importance to the septa; and indeed they are more solid and stronger than the higher orders of them. Moreover they modify the condition of the lower parts of each interseptal loculus.

Seen from above, the synapticula are in series in each interseptal loculus, and look like cross bars. Seen from the side, after fracturing a coral across, the synapticula are stout, nearly vertical or curved continuous ridges with a considerable vertical development. Each ridge is of course a fractured synapticulum, and is followed by a corresponding groove, one side of which is the septum bearing the synapticulum, and the base of which may be closed below, or it may open outwards by the perforations at the base. As there is a series of the synapticula in each interseptal loculus, there is a row of these ridges extending more or less from the axial space to the circumference along the septum or septa (Pl. V. fig. 1), and each ridge is separated from its neighbours by a groove. In the normal condition of the parts, each inter-

septal loculus is filled up in its lower part, and up to a level with the top of the smaller septa, by vertical or slightly curved solid beam-like bodies with intervening canals, some of which open through the base.

This canal-system is most complete in *Fungia* and *Herpolitha*.

The synapticula are grooved longitudinally, both axially and circumferentially, so as to enlarge the lumen of the canal; and this gives the nipped-in appearance when they are seen from above. They are very equal in size in the same corallum, exceptions to the contrary relating to immature structures; but large solid septa are united to most delicate cribriform ones by as large synapticula as are seen between well-developed septa. Again, thin fragile septa unite with each other by dense synapticula as large as those found between solid septa.

The synapticula may be seen on the side of a large septum in series, yet without a thin septum adhering to their flat free extremity; and hence the synapticulum may develop prior to one of the septa to which it will eventually become attached.

The extreme vertical height of the synapticula in *Fungia* in the specimens examined was 12–14 millim.; and they were as stout as the walls of many corals, ·5 millim. The spaces between them, or canals, are narrower.

In *Halomitra* the synapticula are long, vertical, and curved in some parts, and are a succession of linear nodules in others; and it is to be noticed that whilst in *Fungia* the perforate condition of the septa makes no difference in the continuity of the synapticula, the fenestrate condition in *Halomitra* clearly relates to their discontinuous nature.

The sides of the septa of Fungidæ examined are ornamented with granules in rows and concentric series or in vandykes. This ornamentation differs in its direction from the synapticula, and may be seen between them in some instances.

Finally, the fibrous structure of the corals, made up of very minute elongate prisms and fusiform bodies, is discontinuous here and there between septa and synapticula; and these last are often formed independently of the septa. Frequently the synapticulum is a direct offshoot of two septa; and the halves unite along a line indicated by the presence of more connective tissue than usual and by a difference in the direction of the ultimate fibres.

DESCRIPTION OF THE PLATES.

Plate V.

Fig. 1. *Fungia echinata.* Fracture across the coral, showing palisade-like septa, cribriform septa, perforations in the base-wall, and long curved synapticula. × 2.

2. Ditto. The same, with imperfect synapticula. × 2.

3. *Fungia scutaria*, var. Fracture across the coral, showing strong nearly vertical and curved synapticula and solid and cribriform septa.

4. Section tangential to the circumference of the same specimen, showing the synapticula cut across in various parts of their course.

5. View of surface of coral, showing the tops of the synapticula in the interseptal loculi.

6. The direction of the ultimate fibrous structure in a cribriform septum. × 300.

7. The direction of the fibres in a septum and synapticula on either side; the dark wavy lines are connective tissue. × 300.

8. Part of the end of a septum with fibres resolved into crowds of spicules; tubes of *Achlya penetrans*, nobis, are parasitic. × 400.

Plate VI.

Fig. 1. *Halomitra crustacea.* The corallum.

2. Fracture removing one septum from its neighbour, showing perforate base-wall, upright stout synapticula joining together by cross pieces; above are the ornamental granules of the free septal edge. × 3.

3. Another view, showing a stout massive synapticulum. × 3.

4. Part of a calice, showing synapticula from above. × 2.

5. The perforated base, from below. × 2.

6. *Herpolitha limosa.* A fracture, showing synapticula and basal perforations.

7. Synapticula, seen from above, between granular septa.

8–10. Microscopic views of the spicules of *Fungia scutaria*, var. × 600. Diameter of spicule $\frac{1}{4000}$ inch.

On the Pairing of *Tegenaria Guyonii*, Guér., with a Description of certain Organs in the Abdominal Sexual Region of the Male.

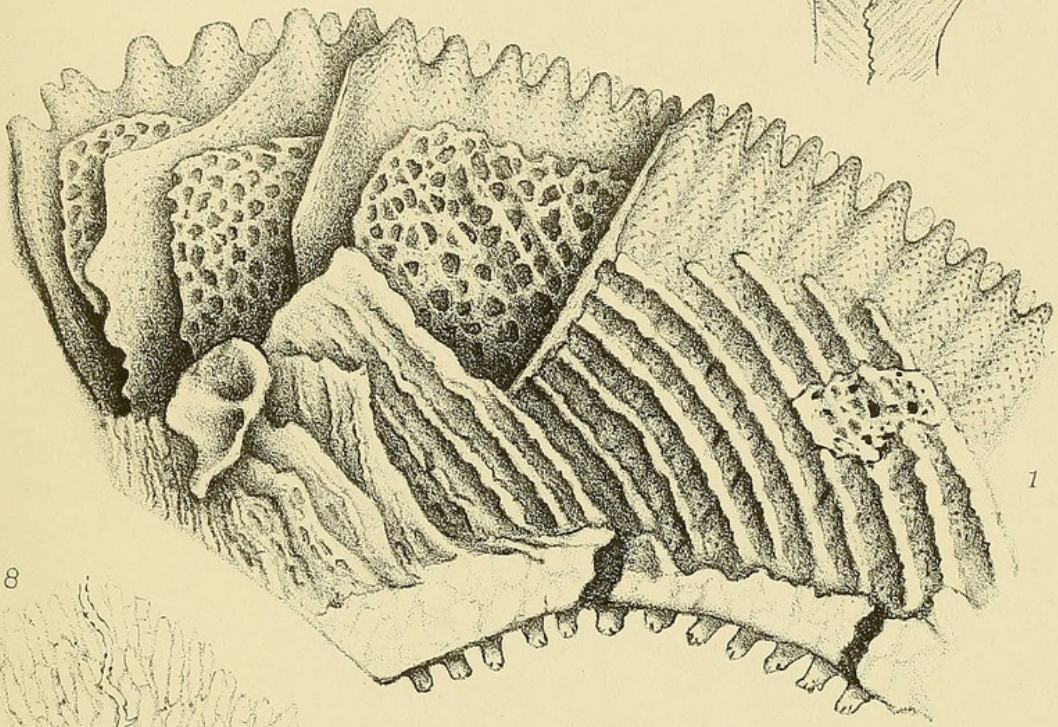
By F. Maule Campbell, F.L.S.

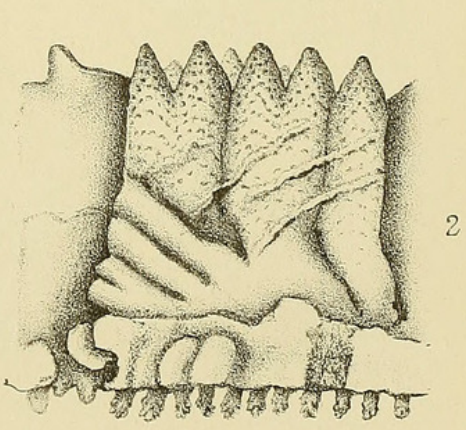
[Read February 1, 1883.]

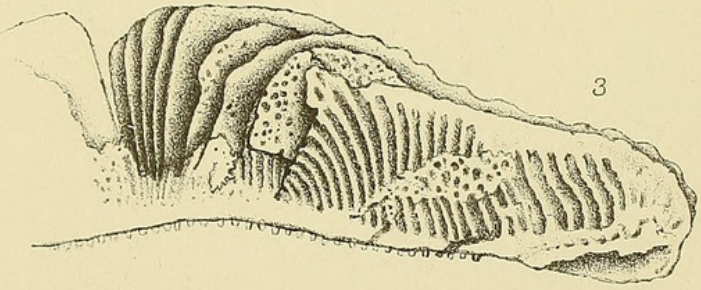
(Plates VII. & VIII.)

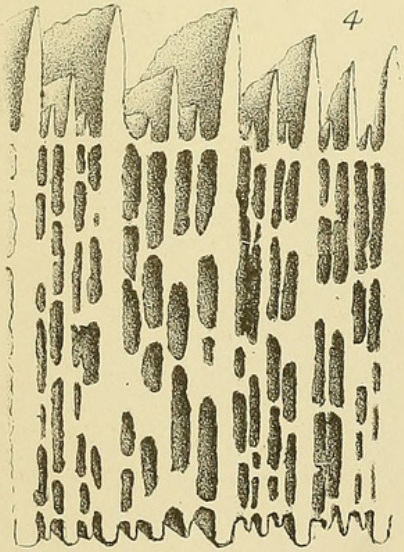
Pairing of Tegenaria Guyonii (*Guér.*).

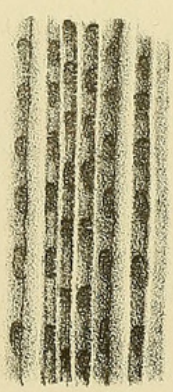
The relation between the palpi and abdominal sexual organ of male Spiders was discovered by Menge ("Ueber die Lebensweise

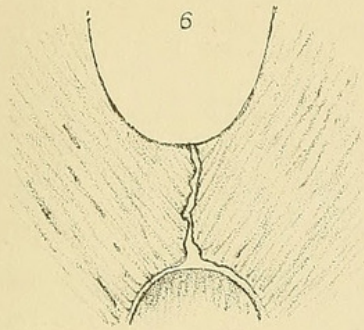


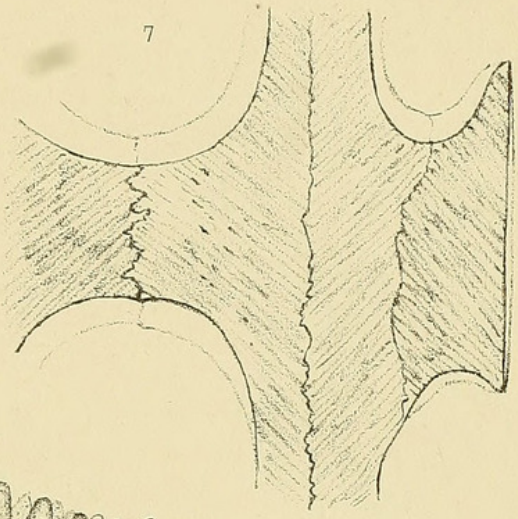


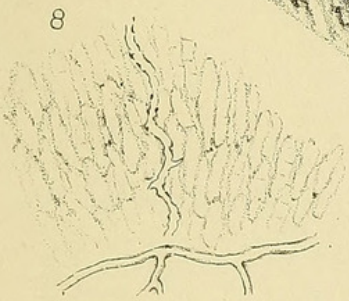




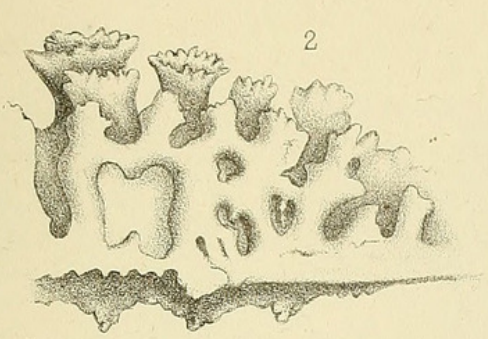


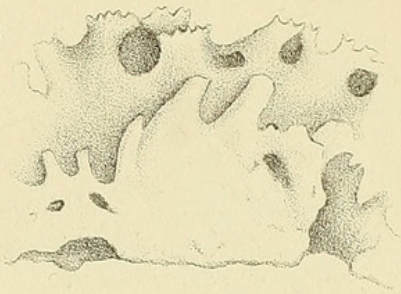


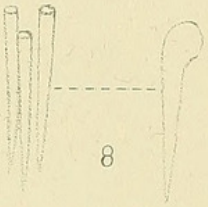


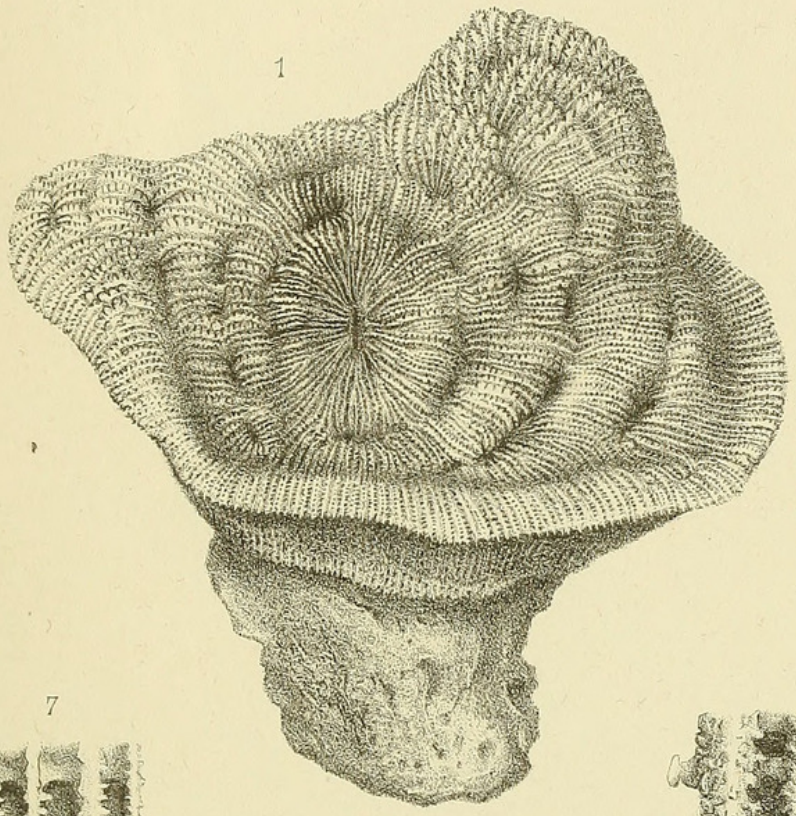


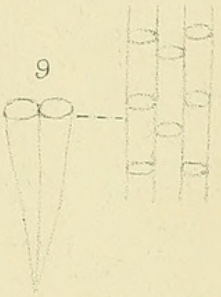
Berjeau del. et lith. STRUCTURES OF FUNGIDÆ. M&N Hanhart imp.

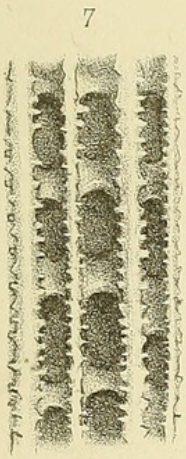


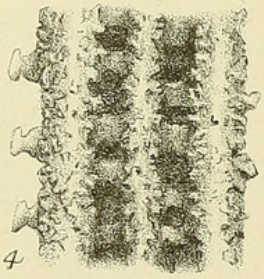


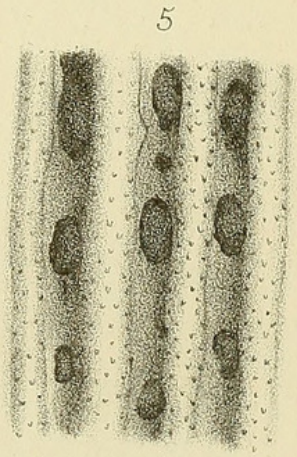


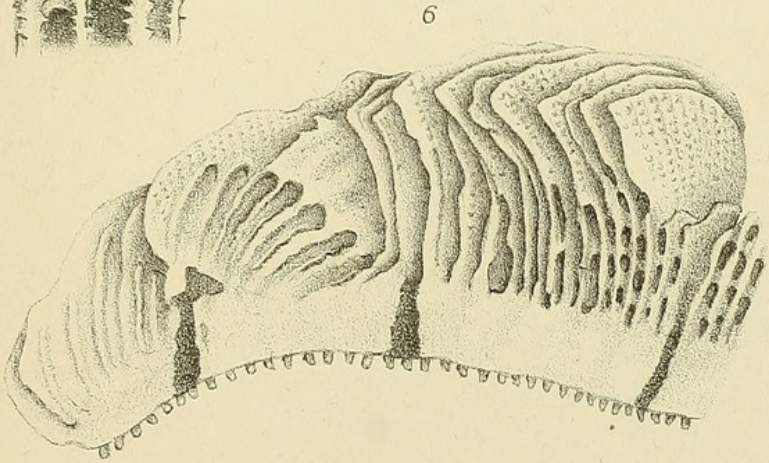












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