THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY,

INCLUDING

ZOOLOGY, BOTANY, AND GEOLOGY.

(BEING A CONTINUATION OF THE 'ANNALS' COMBINED WITH LOUDON AND CHARLESWORTH'S 'MAGAZINE OF NATURAL HISTORY.')

CONDUCTED BY

ALBERT C. L. G. GÜNTHER, M.A., M.D., Ph.D., F.R.S.,
WILLIAM S. DALLAS, F.L.S.,
WILLIAM CARRUTHERS, F.R.S., F.L.S., F.G.S.,
AND
WILLIAM FRANCIS, Ph.D., F.L.S.

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"Omnes res creatæ sunt divinæ sapientiæ et potentiæ testes, divitiæ felicitatis humanæ:—ex harum usu *bonitas* Creatoris; ex pulchritudine *sapientia* Domini; ex œconomiâ in conservatione, proportione, renovatione, *potentia* majestatis elucet. Earum itaque indagatio ab hominibus sibi relictis semper æstimata; à verè eruditis et sapientibus semper exculta; malè doctis et barbaris semper inimica fuit."—LINNÆUS.

"Quel que soit le principe de la vie animale, il ne faut qu'ouvrir les yeux pour voir qu'elle est le chef-d'œuvre de la Toute-puissance, et le but auquel se rapportent toutes ses opérations."—BRUCKNER, *Théorie du Système Animal*, Leyden, 1767.

. . . . The sylvan powers
Obey our summons; from their deepest dells
The Dryads come, and throw their garlands wild
And odorous branches at our feet; the Nymphs
That press with nimble step the mountain-thyme
And purple heath-flower come not empty-handed,
But scatter round ten thousand forms minute
Of velvet moss or lichen, torn from rock
Or rifted oak or cavern deep: the Naiads too
Quit their loved native stream, from whose smooth face
They crop the lily, and each sedge and rush
That drinks the rippling tide: the frozen poles,
Where peril waits the bold adventurer's tread,
The burning sands of Borneo and Cayenne,
All, all to us unlock their secret stores
And pay their cheerful tribute.

J. TAYLOR, *Norwich*, 1818.

ALERE FLAMMAM.

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THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FIFTH SERIES.]

"................... per litora spargite muscum,
Naiades, et circùm vitreos considite fontes:
Pollice virgineo teneros hìc carpite flores:
Floribus et pictum, divæ, replete canistrum.
At vos, o Nymphæ Craterides, ite sub undas;
Ite, recurvato variata corallia trunco
Vellite muscosis e rupibus, et mihi conchas
Ferte, Deæ pelagi, et pingui conchylia succo."
N. Parthenii Giannettasii Ecl. 1.

No. 73. JANUARY 1884.

I.—*On the Fertilization of the* Florideæ. By Prof. F. SCHMITZ*.

[Plates I. & II.]

RECENT botanical investigations have proved, in more and more numerous cases, that in sexual fertilization a direct union of two sexually differentiated cells takes place, the product of which, as a fertilized ovicell, becomes developed into the germ of a new plant. At the same time it appeared that the most essential point in this union of the two sexual cells was the union of the nucleus of the male cell, which sometimes constitutes almost the entire mass of this male cell, with the nucleus of the female cell, in precisely the same way as also occurs in the fertilizing processes of animals†. Nevertheless several processes of fertilization not satisfactorily explained have hitherto stood in the way of a generalization of these

* Translated by W. S. Dallas, F.L.S., from the 'Sitzungsberichte der kön. pr. Akademie der Wissenschaften zu Berlin,' 1883, p. 215.

† See also Strasburger, "Ueber den Befruchtungsvorgang," Sitzungsb. niederrhein. Gesellsch. für Nat.- und Heilkunde zu Bonn, 4th December, 1882.

results. The Florideæ, especially, in which the union of the two sexual cells usually has as its consequence the further development of a third more or less distinct cell, present great difficulties to a general theory of sexuality.

My own observations upon the development of the Squamarieæ* had led me to the discovery of peculiar processes in the formation of the fruit in that group of Florideæ, which joined on to the previous observations of Thuret and Bornet on the fructification of *Dudresnaya* and *Polyides*. This induced me to extend my investigations further, and to attempt the general solution of the question of the mode of sexual fertilization and fructification in the Florideæ. The solution of this problem was rendered remarkably difficult by the circumstance that in my dwelling-place (situated far inland) the procuring of the requisite material for investigation was attended with the greatest difficulty. Hence I feel it to be my duty to offer my special thanks to the Royal Academy of Sciences in Berlin, for having enabled me to make a long sojourn on the sea-coast in the autumn of 1881. And I also express my most grateful thanks to Dr. Bornet of Paris for his liberal and always ready assistance with material for investigation.

This difficulty of procuring suitable material for examination, in order to complete and conclude the studies that I had commenced, may also justify me in bringing together in what follows† the results obtained, as a report upon my investigations up to this time, without at present going much into detail. I propose still further to continue this investigation of the Florideæ, and, if possible, to complete it by the examination of all the types of the European seas.

I.

The thallus of the Florideæ is generally composed of branched cellular filaments. These individual branched cellular filaments are sometimes free (*Chantransia*, *Callithamnion*), sometimes held together by a more or less dense jelly (*Batrachospermum*, *Crouania*, *Nemalion*), sometimes so firmly and closely involved by a very dense and tenacious intercellular substance as to represent a parenchymatous cellular

* Sitzungsb. niederrhein. Gesellsch. für Nat.- und Heilkunde zu Bonn, 4th August, 1879, pp. 376, 377.

† The numerous statements in literature which are opposed to various individual points in the following statement cannot here be entered upon in detail. This must remain for a future special elaboration of the different groups of the Florideæ.

body*. Sometimes in this case the main branch of a system of ramification projects particularly in the midst of its numerous lateral branches (*Batrachospermum*); sometimes, by rapid growth of the lateral branches which arrange themselves beside it in equal development and strength, it becomes concealed and unrecognizable.

The individual filaments increase in length by apical growth with acropetally advancing division of the terminal cell, which sometimes exceeds the rest in size, and is then easily distinguished as the apical cell, and sometimes does not differ from the other cells. Hence the individual branches of the thallus are sometimes seen to be provided with a distinct apical cell at the apex of the main branch of the whole system of ramifications, and sometimes, if neither the main shoot of the system of ramifications nor the terminal cells of the individual branches stand out distinctly, they grow in length apparently with an apical surface, while in all cases the same mode of apical growth takes place.

The apical growth of the cellular filament is generally followed by a frequently *very* abundant intercalary growth by extension of the individual cells. In this case, however, no (orthogonal or oblique) transverse division of the individual joint-cells ever takes place, any more than a longitudinal division, with a divisional wall occupying the organic longitudinal axis of the cell†. The only divisions which break

* From this dissimilar structure of the thallus the differences in habit of the different forms of thallus appear much greater than the differences of the general mode of growth really are. These essentially consist in a different behaviour of the older lamellæ of the mother-cell membranes. Thus if these older lamellæ of the mother-cell membranes are perforated locally during the outgrowth of a branch-cell, the branch-cell grows into a free filamentous branch. On the other hand, if these lamellæ are only stretched and lifted up by the growing branch-cell, the branch-cell remains united with the neighbouring cells in a more or less closely packed so-called parenchymatous cell-union, and held together by a common external membrane. If these common cell-membranes then swell up gelatinously the thallus assumes the form of a system of branched cellular filaments, which are enclosed and enveloped by a more or less dense jelly.

This heterogeneous development of the thallus consequently never precludes a near relationship of two Floridean genera, however different they may be in habit at the first glance.

For the same reason, however, a near relationship of two genera cannot any more be excluded because the spore-forming mass of tissue, the so-called nucleus of the cystocarp, forms, in the one case, a closed cellular body, and in the other a branching tuft of filaments (compare, for example, *Helminthora* and *Nemalion*, *Callithamnion* and *Seirospora*, *Cruoria* and *Cruoriopsis*, *Chylocladia* and *Lomentaria*, &c.).

† For the establishment of this fact, in many cases, very wearisome and troublesome investigations are necessary, so that it may easily be

up the individual filament cells, rather cut portions of the margins off*, which then become developed into longer or shorter lateral branches.

These marginal cells are formed on the individual joint-cells, sometimes singly, sometimes in plurality, sometimes simultaneously, sometimes one after the other, and, according to their number and their earlier or later development, they produce a very heterogeneous habit of the cell-division and of the ramification of the individual filaments. A very widely spread mode is that at the upper end of a newly produced joint-cell a branch-cell is at once separated off which extends itself by the side of the terminal cell of the filament almost as rapidly and strongly as the latter itself, and thus readily produces the appearance of a regular dichotomous branching; in what follows this mode of ramification is characterized as *subdichotomous* as by Bornet.

At each division of a Floridean cell a peculiar pit is formed in the organic central point of the dissepiment formed; this maintains the two sister cells in communication so long as they remain alive†.

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overlooked. In literature therefore there are many contradictory statements (by Nägeli, Kny, Reinke, &c.). In all cases, however, that I have hitherto been able to investigate I have been unable to confirm these statements; and now, after very numerous investigations, I believe I am justified in establishing the above propositions as generally applicable to the Florideæ. Should exceptions really occur here and there, they certainly take place extremely seldom.

* Upon the circumstance that in the Florideæ a joint-cell is *never* divided by a transverse wall, or by an (organically) median longitudinal wall, but that rather lateral marginal cells only are cut off from such joint-cells, depends also the fact that the cellular tissue of the Floridean thallus is *always* to be referred back to a system of branched cellular filaments, even when the thallus is solid and the individual cells are held together without gaps. Every cell-body constructed under this condition must show the same behaviour; and it is due only to the cessation of this condition that the roots, stems, leaves, &c. of the Archegoniata and Phanerogamia also cannot be referred back to a system of simple branched cell-filaments.

The Ascomycetes, however, show an exactly similar behaviour to the Florideæ; in the great majority of them a transverse division of the individual joint-cells of vegetative cell-filaments takes place but rarely. In consequence of this the construction of the thallus out of branched cell-filaments usually appears just as distinctly in these Ascomycetes also as in the Florideæ; and the occasional occurrence of parenchymatous cell-bodies (*e. g.* in the foundation of the perithecia of *Pleospora herbarum* [*cf.* Bauke in the 'Botanische Zeitung,' 1877, pp. 315 *et seqq.*]) is probably due, just as in the Florideæ, only to a close firm conglobation of the very short-jointed branched cell-filaments.

† Such a pit consequently occurs both in the lower and in the upper septum of each joint-cell. Between the two pits of these two transverse

In any subsequent division of the cell, by which, as already mentioned, marginal cells alone are always separated, this pit never occurs in any such marginal cell, but is always preserved in the joint-cell itself. The same thing is repeated at each cutting off of a marginal cell, so that from the number and distribution of these pits, even in the quite unequally extended cells of full-grown branches of the thallus, the genetic connexion of the individual cells with the whole of their neighbour-cells may be recognized, at all events so long as the occurrence of secondary pits does not produce difficulties. Such secondary pits, however, frequently occur, especially in species with a small-celled thallus, developed in such a manner that the individual thallus-cells are placed in connexion with all the neighbouring cells by *subsequent* development of one or more pits in the separating septa, indifferently whether they are or are not separated by these septa from sister-cells. Nay, even the cells of the secondary rhizoidiform medullary-filaments of the thicker Floridean stems are sometimes brought into close connexion with individual cells of the tissue through which they grow, by such secondary pits.

These pits (which are generally circular) are closed by extremely thin membranous lamellæ. But on each side of these closing membranes there always lies a thick lamina of a very dense substance (very easily and intensely coloured* by hæmatoxyline and analogous staining materials), and this so closely and firmly that it can rarely be separated, and only by swelling up of the closing membrane†. The two plates are

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walls runs the organic longitudinal axis of the joint-cell. As already stated, no transverse division nor any (organically) median longitudinal division ever occurs in a joint-cell, and consequently no dissepiment is ever formed in the joint-cells which either cuts their organic longitudinal axis or includes it; hence it follows that the joint-cell must *always* retain the two original pits in the two end-surfaces, as indeed is the case.

* With regard to this behaviour with colouring agents the substance of these closing plates of the pits shows a very close analogy with the so-called mucilage of the sieve-tubes, which, however, I think, on the ground of repeated investigations (on Cucurbitaceæ), must be regarded quite otherwise than is now commonly the case.

Thus, while this mucilage is generally regarded as lifeless, and supposed to travel in the sieve-tubes from cell to cell, I am quite unable to find in the facts any support for such a migration of the mucilage. In my judgment this "mucilage" rather remains in a *definite* form (which, however, is exceedingly easily destroyed in preparation) in the individual cells in which it was produced. In the more complicated cases (*e. g.* in the Cucurbitaceæ) the formed mucilage-masses (closing plates of the sieve-plates and uniting hollow cylindrical cords) of the individual joints of the sieve-tubes (cells) all remain in connexion with each other, and thus form in the plant a connected system of peculiar cords.

† I succeeded in effecting this in a very instructive manner in speci-

directly connected by numerous cords, which principally (sometimes apparently exclusively) perforate the closing membrane at the periphery of the pit, and here often coalesce laterally into hollow cylindrical bands*.

On the other hand, however, these plates are directly and firmly coherent with the parietal protoplasm of the cell, and apparently form only the completion of the parietal protoplasmic sac † along the surfaces of the pits; in reality, however, they are probably, at least towards the lumen of the cell, coated with a very thin layer of protoplasm. In dead material, the cell-walls of which usually swell up more or less in a gelatinous form, the pairs of laminæ remain united, and in accordance with this we see the contracted plasma-body of all the individual cells more or less drawn out into cord-like processes towards the neighbouring cells, connected together by means of these pairs of laminæ.

Thus by means of the cords which traverse the closing membranes of the pits and unite the two laminæ of the different pairs, a direct connexion of the neighbouring cells with one another is established, and thereby a direct union of all the cells of the thallus is attained ‡, enabling these thallus-cells, notwithstanding their extraordinarily great number, by unitary cooperation to form a single whole, a single individual plant §.

mens of *Griffithsia Schousbœi*, J. Ag., and *Pterothamnion plumula*, Näg., which had been hardened with picric acid.

* How far analogous closing-plates also belong to the pits of other Algæ (Fucaceæ, Dictyotaceæ, Volvocaceæ, &c.) can only be decided by further investigation. The fact that, on the contraction of the plasma, plasma-cords remain pretty regularly attached to these pits, leads one to expect similar conditions in the structure of these pits. But the small size of most of these structures greatly increases the difficulty of deciding the question with certainty.

† Whether these laminæ are produced by local differentiation (chemical transformation) of the parietal protoplasm, may for the present remain an open question. I regard this, however, as not improbable.

‡ The direct connexion of all the cells of the thallus by means of these pits has already been indicated by Bornet ('Etudes Phycologiques,' p. 100), who, however, regards these pits as perfectly open canals. He even endeavoured, through this direct connexion of all the thallus-cells, to explain how, from the fecundated female cell, the fertilizing influence propagates itself to that cell which grows into the spore-fruit.

§ In my opinion these connecting cords between the two closing plates of the pit serve essentially for the transference of dynamic influences from cell to cell; the corresponding pores of the cell-membrane, however, at the same time render possible a readier exchange of dissolved substances between the two neighbouring cells. A migration of protoplasm itself from one cell to another by means of these open communications I regard as inadmissible.

Various facts indeed seem to me to favour our regarding the two

An open communication, so that an interchange of formed protoplasmic portions, cell-nuclei, or chromatophores could take place between the two neighbouring thallus-cells, is, however, not established by these pits. Such an open communication is indeed formed only in a few cases (Corallineæ*) by the development of large open pores which are produced subsequently in the common dissepiment of neighbouring thallus-cells, analogous to the widely diffused H-shaped connexions of the hyphæ of Ascomycetes and Basidiomycetes.

II.

On this thallus the sexual cells originate by the differentiation of certain terminal cells of the entire system of branched cell-filaments.

The *male cells* are usually formed in great numbers together. Close to the generally small terminal cell of a shorter or longer branch-filament (one or) several small branch-cells are formed by the uppermost joint-cells, and these, like the terminal cell itself, become developed into male cells. The same thing is repeated in the second and often in the third joint-cell (sometimes also in the following joint-cells), or short, one- or more-celled lateral branchlets issue from these joint-cells, the terminal cells of which, as well as the branch-cells of the superior joint-cells, become converted into male cells. Hence the male cells are placed several together at the apex of the uppermost cell and at the upper end of the next following joint-cells of a simple or ramified branch-filament. Such branches are distributed sometimes singly, sometimes united in groups on the thallus of the different species of Florideæ, and thus form so-called *antheridia* of very multifariously variable structure.

Such antheridia sometimes present the form of separate larger or smaller tufts of filaments (*Callithamnion*, *Scinaia*, &c.); but generally a greater or less number of such tufts

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closing plates of the pits as those organs of the individual cells which receive and use up the stimuli transmitted from neighbouring cells. And likewise, for various reasons, I would regard it as not impossible that the above-mentioned "mucilaginous masses" of the sieve-tubes (which, in my opinion, agree in substance with the closing plates) possess a function perfectly analogous to that of these closing plates and their connecting cords, namely, essentially the using up and conduction of dynamic influences, so that Hanstein's idea ('Protoplasma,' p. 172), that possibly the sieve-tubes of plants are comparable to the nerves of animals, would be confirmed.

* See Schmitz in 'Sitzungsb. niederrh. Gesellsch. für Natur- und Heilkunde,' 1880, p. 122.

are collected into groups covering larger or smaller portions of the surface of the thallus (*Nitophyllum*, *Peyssonelia*, *Polyides*, *Ceramium*, &c.). Sometimes these groups are immersed and line depressions of the surface of the thallus, or these depressions may even be converted into pitcher-like receptacles, which, in their development, present the greatest resemblance to the spermogonia of the Lichens and Ascidiomycetes (*Gracilaria*, *Galaxaura*, and many Corallineæ). In all cases, however, the male cells originate exclusively (I have never observed an exception) from the terminal cells of longer or shorter branches of the thallus-filaments, never from their joint-cells*.

In all exactly investigated cases the individual male cell appeared colourless from its first origin onwards; formed chromatophores were never to be recognized in it. On the other hand, a pretty large nucleus was everywhere to be detected in the protoplasm, which usually contained some small shining granules. At the complete maturity of the male cell its membrane ruptures at the apex and the plasma-body issues forth as a solid spherical or elongated body, which is sometimes drawn out into a tail-like point at the inferior extremity (*Cruoria purpurea*, *Corallina*, *Amphiroa*). In the interior of this escaped *spermatium*, however, a tolerably dense protoplasm with some small shining granules always encloses a pretty large cell-nucleus, which is sometimes central, sometimes rather excentrically placed.

The development and emission of the individual spermatia of an antheridium takes place gradually. Very frequently, however, after the evacuation of a spermatium-mother-cell, its supporting cell grows through it and develops, within the empty envelope of the spermatium-mother-cell, a new male cell (*Batrachospermum*, *Chantransia*), until the contained masses of the supporting cell are used up.

The individual escaped spermatia represent small membraneless cells, which, according to the prevailing opinion, are destitute of any spontaneous mobility. My own observa-

* Some few contradictory statements in literature (on the formation of the spermatia of *Melobesia deformans*, in Solm's 'Corallinenalgen des Golfes von Neapel,' p. 53, and of *Hildenbrandtia rivularis*, in Borzi 'Rivista Scientifica,' i. no. 1, Messina, 15 May, 1880) I must leave out of consideration for the present, as I have not myself been able to investigate the cases referred to. But as I have found the above-given rule confirmed in all carefully investigated Florideæ, even when the first glance at the antheridia gave one the impression of a quite different mode of development, I must regard it as not improbable that on more exact investigation the above-mentioned exceptional cases may also be referred to the same rule.

tions have also hitherto failed in detecting, *with certainty*, in these cells either any locomotive organs, or, indeed, a striking spontaneous mobility of any kind. But one series of observations* leads me to think that the prevalent supposition, according to which the spermatia only reach the female cells passively by the movement of the surrounding water, by no means entirely exhausts the facts; and I would therefore prefer, for my own part, to leave the question of the mobility of the isolated spermatia still undecided.

III.

The female sexual cells of the Florideæ originate without exception from the terminal cells of longer or shorter lateral branches of the whole system of ramification of the filaments of the thallus. These branches are frequently formed only as secondary lateral branches after the formation of all the other ramifications. Sometimes they are confined to a very small number of cells (two or three, rarely one), sometimes they attain a greater length; and while sometimes they do not differ in structure from the other neighbouring sterile branches, in most cases they may easily be distinguished by their form†, the size of their cells, or the different branching of their joint-cells. In all cases, however, their terminal cell finally be-

* For example, when observing living spermatia of *Polysiphonia elongata*, Grev. (at Heligoland), I quite distinctly saw a single spermatium travel slowly through the field of the microscope, while the other spermatia lay quite still.

Several times I also saw spermatia of the same *Polysiphonia* attached in such a manner that the globular spermatium stood off from the supporting surface about twice the length of the diameter of its body, although still firmly adhering to it, as it accompanied all (even the smallest) movements of the supporting body with pendulum-like oscillations. It was natural to see in the filamentous connecting cord which, from what has been said, it must be assumed attached the spermatium to the supporting body, the cilium of the spermatium which has hitherto been sought in vain. But, unfortunately, notwithstanding all my endeavours, I was unable *clearly* to detect this supposed cilium, often as I thought I could discern it.

A further indication of spontaneous mobility in the spermatia of the Florideæ is to be found in the fact that in *Batrachospermum* the spermatia must penetrate through the gelatinous envelope of the branches of the thallus in order to reach the apex of the completely immersed carpogonia. They can hardly be capable of such penetration without some proper (perhaps amœboid?) mobility.

† These branches appear to be particularly noteworthy on account of their similarity to the "procarpia" of the Collemaceæ, as in *Batrachospermum Julianum*, Arcangeli, according to the description of Arcangeli (Nuov. Giorn. Bot. Ital. xiv. 1882, pp. 160 *et seqq.* tav. v. figs. 1–8), in which species the female cell occupies the apex of a short-jointed spirally-contorted branch.

comes converted into the female sexual cell by allowing a diverticulum to issue from its apex, which elongates into a longer or shorter hair-like or clavate process, the *trichogyne*, which has sometimes one or more spiral contortions (figs. 17, 23) or is bulbously dilated (fig. 33) at the base. This female cell may be here described as the *carpogonium* * (by analogy with the oogonium of the Chlorophyceæ).

At the period of fertilizable maturity the carpogonium contains, in its usually ovate ventral portion, a very abundant protoplasm with a large distinct cell-nucleus. Sometimes also well-developed more or less intensely coloured chromatophores are contained in this protoplasm (*Nemalion*, *Helminthocladia*, *Batrachospermum*); but in other cases the protoplasm of the carpogonium is perfectly hyaline. The trichogyne into which this bellied part of the carpogonium is continued by means of a short neck-like constriction, is filled with colourless protoplasm, which is usually free from vacuoles in the apex itself, but pervaded by more or less numerous vacuoles in other parts, and also contains some larger or smaller shining granules of variable number and distribution (fig. 8), which behave towards staining agents like the chromatine granules of the cell-nucleus.

At this time the cells of the *carpogonial branch* (*i. e.* of that branch the apical cell of which becomes converted into the carpogonium) present a very different development in the different genera and species. In many instances (*Batrachospermum*, *Lemanea* sp., *Naccaria*, *Chondria*, &c.) they are furnished with more or less numerous lateral branches, while in other cases they are unbranched. Sometimes the whole of these cells are somewhat enlarged, and filled with more or less numerous plasma-masses; in other cases only certain joint-cells of the carpogonial branch are enlarged and abundantly furnished with contents (*Calosiphonia*); but the uppermost of these joint-cells, the hypogynal cell, is particularly often distinguished from the other cells by its stronger development (*Glœosiphonia*, figs. 8–10, *Scinaia*, &c.).

These fertilizably mature carpogonia then in most cases extend the apex of their trichogyne beyond the surface of the thallus and into the surrounding water. In certain cases,

* The terminology of the organs of fructification of the Florideæ is at present rather uncertain. The expressions "carpogonium," "procarpium," "carpogenous cell," "trichogyne," "trichophore," "fructifying tube," &c. are used by different authors in very different ways. I have therefore found myself for my present purpose compelled to settle this terminology, which, moreover, frequently was not suited to modern conceptions, quite independently, although still, as far as possible, employing previously established terms.

however, the apex of the trichogyne remains concealed in the interior of the thallus, that is to say, enclosed within its gelatinous envelope (*Batrachospermum*). But in both cases the isolated spermatia (by spontaneous movement?) reach the apex of the trichogyne and attach themselves to it, at the same time (hardly previously) surrounding themselves with a membrane. Then the membrane of the spermatium and apex of the trichogyne is resorbed at the point of adhesion, and through this opening the two masses of contents are placed freely in connexion. In this way the plasma-bodies of the carpogonium and spermatium unite to form a single coherent cell, which at first still contains two different cell-nuclei.

In the next developmental stage the cell-nucleus of the spermatium has disappeared from its previous place and is nowhere to be discovered in the interior of the conjugation-cell, but in the bellied part of the carpogonium there is, as before, a single cell-nucleus. A fusion of the two original cell-nuclei to form this latter cell-nucleus could nowhere be directly perceived. Nevertheless, from the analogy of other cases, it may with the greatest probability be assumed that the cell-nucleus of the spermatium travels through the trichogyne into the bellied part of the carpogonium, and here amalgamates with the cell-nucleus of the carpogonium.

The cell-wall then thickens in the neck of the trichogyne and narrows the central opening more and more until finally this is completely closed in the middle (figs. 1, 2–4, 6, 7, 10, 16, 23, 35). In this way the connexion between the bellied part of the carpogonium and the trichogyne with the spermatium is interrupted by means of a more or less thick membranous plug, and the whole conjugation-cell divided into two independent cells.

These two division-cells, however, are of quite different value, inasmuch as only the lower cell possesses a cell-nucleus and now commences a rapid further development; the upper one, on the contrary, is quite destitute of a formed cell-nucleus, and remains inactive until its earlier or later disappearance. The former represents the fecundated female cell, the *fertilized ovicell*; the latter, on the contrary, forms a useless part of the conjugation-product of the two sexual cells, which is now divided off and thrown aside, while the fertilized ovicell prepares for further development.

In the interior of the separated trichogyne-cell there are frequently, varying in number and form, larger or smaller granules which behave towards colouring-agents like the chromatine corpuscles of cell-nuclei, but never belonged to formed cell-nuclei (fig. 1). I have not been able to ascertain whether these granules, which are already present within the trichogyne in the fertilizably mature carpogonium, are given off by the cell-nucleus of the carpogonium; but it seems not improbable that they really originate from the chromatine corpuscles of that cell-nucleus. The described process of fecundation would then have to be explained as follows:—that in the female cell, the carpogonium, the separation of the directive body (*i. e.* a portion of protoplasm with the separated useless portions of the cell-nucleus) does not take place until after the union of the male cell with the female cell, and the fusion of the male cell-nucleus with the nucleus of the female cell. I have no hesitation * in fact about interpreting the processes described in this manner †.

Fecundation is effected in the manner just described in all the Florideæ hitherto exactly investigated by me, however different the form of the trichogyne may be in the individual cases. Everywhere this trichogyne, after fecundation had taken place, was divided off as a non-nucleated cell from the fecundated ovicell by the closure of the short neck of the trichogyne, and abandoned to destruction. The fecundated ovicell, however, then immediately commenced a very active new growth.

IV.

In this recommencing growth the fertilized ovicell by no means separates from its previous tissue-connexions (as in the oogonia of the green Algæ or the archegonia of the Archegoniata), but rather remains afterwards as before in unaltered connexion with the neighbouring hypogynous cell and retains the old cell-membrane of the carpogonium as its own cell-membrane, extending and strengthening it as required. Nay,

* In most instances, certainly, in plants (as in animals), the directive corpuscle is separated before the fecundation of the female cell (see Strasburger, 'Befruchtung und Zelltheilung,' pp. 79, 80), as, for example, among the Algæ in *Œdogonium*, *Coleochæte*, and *Vaucheria* (in the last-named alga the directive corpuscle contains numerous small fragments of nucleus which have been separated off from the numerous cell-nuclei of the young oogonium). But an expulsion of the directive corpuscle only *after* fecundation has taken place cannot be regarded as at all inconceivable if we consider that in the expulsion of the directive body only an evidently useless part of the cell-nucleus with some protoplasm is separated and thrown off from the female cell, but that such a rejection of the separated part of the cell-nucleus may just as well take place before as after the conjugation of the two sexual cells.

† The portion of the female cell destined to be expelled as a directive body was consequently employed before its separation as an extended trichogyne to intercept the spermatium, and thus to facilitate the access of the male cell-nucleus to the nucleus of the female cell.

even the pit which united the carpogonium-cell with the hypogynous cell also continues its function, and places the fertilized ovicell in direct connexion with the hypogynous cell, and through this with the general cellular tissue of the parent plant. Hence the requisite nutritive materials can be transmitted to the growing ovicell in the simplest and most convenient manner. Nay, this connexion of the fertilized ovicell with the tissue of the thallus of the parent plant is so complete, that this fertilized ovicell easily produces exactly the impression of an ordinary thallus-cell, from which, in fact, it can sometimes be distinguished almost solely by its perfectly peculiar further development (*Chantransia corymbifera*, Thur., figs. 2, 3, 4).

This further development of the ovicell is, however, very different in the individual cases.

1. *Helminthocladieæ.*

In the simplest case the ovicell pushes forth one after the other numerous offshoots, *ooblastemas* as they may here be called (fig. 1), which grow into short-jointed cell-filaments of greater or less length, and abundantly subdichotomously branched. The number of these ooblastema-filaments is, however, very variable; sometimes they are produced in great numbers on the whole periphery of the ovicell except the basal surface and the vertex (*Batrachospermum*); sometimes their development on the ovicell is only one-sided (*Chantransia*, figs. 2–4, *Scinaia*, fig. 7); sometimes the ramifications of these ooblastema-filaments are perfectly free (*Batrachospermum*, *Chantransia*, *Helminthocladia*, *Nemalion*, *Scinaia*), and sometimes they are united by a common gelatinous envelope into a nearly globular closed cell-body (*Helminthora*, according to Bornet *). Sometimes also the fertilized ovicell first of all arches upwards and cuts off a large upper daughter-cell, and the ooblastema-filaments then push forth from the whole free surface of this daughter-cell (*Nemalion multifidum*).

In the genus *Lemanea* several ooblastema-filaments grow forth from the fertilized ovicell at the apex of a carpogonial branch, which may be unramified (*L. fluviatilis* and *ciliata*, according to Sirodot's figures †) or furnished with short lateral branches (*L. torulosa*, and, according to Sirodot's figures, also *L. catenata* and *parvula* ‡), and these filaments growing ob-

* Thuret-Bornet, 'Etudes phycologiques,' p. 64.
† Ann. des Sci. Nat. sér. 5, tome xvi. pl. iii.
‡ *Ibid.* pls. iv. and v.

liquely downwards extend into the cavity of the tubular thallus, and here become abundantly ramified.

In all these cases, however, by ramification of the ooblastema-filaments a more or less abundantly and closely compressed tuft of threads is formed, and this sometimes remains naked (*Chantransia*, *Lemanea*), but in most cases is furnished with a more or less dense envelope of cell-filaments proceeding from the carpogonial branch or the neighbouring filaments of the thallus (*Batrachospermum*, *Nemalion*, *Helminthocladia*), which sometimes even close together to form a solid fruit-wall (*Scinaia*). Sometimes also certain of these sterile envelope-filaments grow through the ramification of the fertile tuft of filaments, and become interwoven, as sterile paraphyses, among the branched ooblastema-filaments (*Batrachospermum*).

In certain cases (*Batrachospermum*, *Chantransia*, *Nemalion*, *Helminthocladia*) these ooblastema-filaments finally develop single carpospores from the terminal cells of their ramifications. These terminal cells swell up and become filled with an abundance of contents. At last the membrane at the apex of the cell bursts, and the whole plasma-body escapes as a single naked spore. These spores are successively evacuated from the different terminal cells of the same tuft of filaments; but after the evacuation of the individual terminal cell its supporting cell grows through it and produces within the evacuated membrane a new spore-forming terminal cell, until finally all the nutritive substances of the whole tuft of filaments are used up. In other cases, besides the terminal cells of the ramifications of the tuft of ooblastema-filaments, the upper joint-cells also develop single carpospores in greater or less number, so that these become developed into longer or shorter, simple or branched chains (*Scinaia*, *Lemanea*).

In all these instances, however, the developed fruit, the *cystocarp*, constitutes a more or less richly branched tuft of filaments, sometimes naked, sometimes covered with enveloping filaments, sometimes surrounded by a closed fruit-wall, and either immersed in the thallus or attached externally.

2. *Gelidieæ.*

In the cases hitherto referred to, the spore-forming ooblastema-filaments are nourished during their development from the thallus-tissue of the parent plant by the intermediation of the ovicell, which remains persistent (usually as the central cell of the whole tuft of filaments). This, however, is no longer the case in a group of genera which come nearest to these.

In these forms the fertilized ovicell usually develops only a single ooblastema-filament (*Caulacanthus*, fig. 39, *Pterocladia*), which, ramifying abundantly, turns towards the middle of the branch of the thallus to which it belongs, and with its ramifications clings round the central cord of cells, the so-called *central axis* of the branch, which at this part is frequently (*Pterocladia*, *Wrangelia pectinata*, Ag.) enveloped by a special small-celled tissue with abundant contents. Through the cell-masses of this tissue the ramifications of the ooblastema-filament twist about and frequently attach themselves firmly to individual very full cells of this tissue (*Pterocladia*), or, when it is deficient, to the cells of the central cord itself (*Caulacanthus*, fig. 39), here and there also entering into direct connexion with them by the development of pits (*Wrangelia*). Being abundantly nourished through the agency of this tissue, the branches of the ooblastema-filament then ramify very considerably, and develop from each of the clavate and erected terminal branch-cells either a single spore (*Caulacanthus*) or short chains of two (or more) spores, in the same way as in the Helminthocladieæ already described.

Thus by the abundant ramification of the ooblostema-filament there is produced a tuft of spore-forming filaments, which spread out in the interior of the branch of the thallus, and give rise to a local enlargement of it. This enlargement increases more and more until the maturity of the spores, and becomes constantly more and more distinctly marked off from the remaining sterile part of the thallus-branch. This dilated part then finally constitutes the fruit, the *cystocarp*, of these Floridean genera, the peripheral tissue of the thallus becoming developed into the fruit-wall, in which an aperture of egress is produced by local separation of the cells, while in the interior the mass of the spores is produced around the central cell-cord from the ramifications of the ooblastema-filament.

In some of these forms (*Naccaria Wigghii*, Endl., and *hypnoides*, J. Ag.) a further complication of the course of development of the fruit occurs. Here the carpogonial branch in very different states of development is beset with several short lateral branchlets, and in this way forms a pluricellular complex of larger and smaller cells (figs. 24 and 26 *), generally with abundant contents. The sprouting ovicell now enters into open connexion with one or another of these neighbouring larger cells, with complete amalgamation of the two plasma-bodies (fig. 27), and only then does the ooblastema-

* See the explanation of the figures.

filament shoot forth from the conjugation-cell and become developed in the manner above described. In detail this conjugation of the growing ovicell with neighbouring cells rich in contents (*auxiliary cells*, as they may be called in the sequel) takes place in very different ways according to the species. In general, however, the only object of this borrowing from neighbouring cells rich in contents in connexion with the development of the ooblastema-filament is evidently to strengthen the latter, which originates from the very small fertilized ovicell, and enable it to develop more luxuriantly.

3. *Cryptonemieæ and Squamarieæ.*

In some of the last-mentioned forms, as stated, the cells of the creeping spore-producing filaments enter into close connexion with the cells of the central axis or of its enveloping tissue by the formation of pits, evidently for the facilitation of nutrition. This goes still further in a series of other forms which follow these most closely (*Dudresnaya*, *Polyides*, *Dumontia*, *Calosiphonia*, *Glœosiphonia* *, *Petrocelis*, *Cruriopsis*, and other Squamarieæ).

In these one or several ooblastema-filaments shoot forth from the fertilized ovicell, and these either become immediately diffused in the surrounding thallus-tissue (*Dumontia*, *Glœosiphonia*, fig. 10, *Calosiphonia*, fig. 23), or first of all become connected by pit-formation with neighbouring auxiliary cells (generally cells of the carpogonial branch itself), and then grow further (*Petrocelis Ruprechti*, Hauck), or, lastly, enter into a conjugation with these auxiliary cells, when the ooblastema-threads issue from the conjugation-cell singly or in plurality (*Dudresnaya*, fig. 17, *Polyides*). In all cases, however, the ooblastema-threads, branching abundantly, creep about as thin long-jointed cell-filaments in the interior of the thallus-tissue.

While thus creeping about the apices of these cell-filaments attach themselves to certain cells rich in contents, which are developed in greater or less number in the vicinity of the carpogonial branches within the branch of the thallus. Sometimes these cells are simple joint-cells of the ordinary sterile branches of the thallus-filaments, scarcely distinguished by their size from the other cells of the filament (*Calosiphonia*);

* Berthold has also observed processes similar to those occurring in the above-mentioned genera in other Cryptonemiaceæ (species of *Halymenia*, *Nemastoma*, and *Grateloupia*), but has hitherto published no detailed account of them (see Falkenberg, in Schenk's 'Handbuch der Botanik,' Bd. ii. p. 184). My own attention was called by Berthold to the occurrence of such processes in *Calosiphonia*.

in other cases these cells are easily distinguished by their remarkable size (*Petrocelis*, *Polyides*); in other cases, again, they become developed into peculiarly-formed thallus-filaments, and are thus easy to detect in the midst of the sterile tissue (*Dudresnaya*, figs. 18, 20, *Dumontia*). To these cells, which from their subsequent behaviour are also to be called auxiliary cells, the ooblastema-threads attach and unite themselves.

Sometimes (*Petrocelis Ruprechti*, Hauck) the apex of the ooblastema-thread grows directly to the auxiliary cell and attaches itself firmly thereto. By resorption of the separating membranes the apical cell itself enters into a conjugation with the auxiliary cell. In the majority of cases, however, the apex of the ooblastema-thread grows close by the auxiliary cell, not unfrequently clinging to it (fig. 18), and then separates as a growing terminal cell (fig. 20). But the newly formed joint-cell, which is now applied more or less closely to the auxiliary cell, enters into open connexion therewith by the development of a shorter or longer conjugation-process. In both cases, after the resorption of the separating membranes, the plasma-bodies of the auxiliary cell and the ooblastema-cell unite to form a single cell-body.

The further development of this conjugation-cell is, however, very different in the various individual cases. In many instances (*Polyides*, *Petrocelis*, *Dudresnaya*) the amalgamation of the two conjugating cells is limited to the union of the two protoplasm-bodies into a single cell-body, while the cell-nuclei of the two conjugating cells remain separated, and are still to be found within the two halves of the conjugation-cell. In these cases a process issues laterally from that half of the conjugation-cell which represents the ooblastema-cell, and its apex becomes segmented off as a separate cell (fig. 19), and then, by further growth, gives origin to a distinct spore-complex *. Lastly, in other cases (*Glœosiphonia*) the two conjugating cells fuse together completely, and from the ooblastema-cell the whole of the protoplasm, with the cell-nucleus, gradually passes over into the auxiliary cell until only the external membrane remains (figs. 11, 12). Then the auxiliary cell becomes separated off as an independent

* In *Dudresnaya coccinea*, Crouan, the terminal cell of this process does not grow into a spore-complex (as in *D. purpurifera*, J. Ag.), but it develops into a long-jointed cell-filament, which, as a side-branch of the ooblastema-thread, diffuses itself in the surrounding tissue. But besides this process of the former ooblastema-cell (one or) two spore-processes issue from the same cell (fig. 21), which apply themselves laterally to the former auxiliary cell, grow and close around it, and then produce a single, sometimes indistinctly bilobed spore-complex.

cell from the emptied ooblastema-cell and shoots forth laterally (fig. 13). This outgrowth, however, becomes separated off as an independent cell (fig. 14), and then, as the central cell, gives origin to a single spore-complex (fig. 15).

Thus, in the first case, the individual joint-cell of the ooblastema-thread (after preliminary conjugation with an auxiliary cell) produces a lateral branch-cell which leads to spore-formation, just as in the Gelidieæ, previously described, only that here this cell does not give origin to a single spore, but (just in consequence of the conjugation with an auxiliary cell) to a whole complex of spores, which appears to be individualized as a single fruit or cystocarp. Here the ooblastema-cell is evidently strengthened by the conjugation with the auxiliary cell, and rendered capable of the production of more numerous spore-mother-cells (*Polyides*, *Dudresnaya*). In the latter case, however, this calling in aid of the auxiliary cell passes into a complete amalgamation and union of the ooblastema-cell with the auxiliary cell, after which the resulting conjugation-cell becomes further developed in the same way as the ooblastema-cell assisted by the auxiliary cell in the former case.

Thus, in both cases, either a lateral offshoot becomes separated off as an individual cell and then commences a very rapid growth, or, more rarely, this rapid new growth proceeds from the conjugation-cell representing the ooblastema-cell. More or less numerous marginal cells are separated off from this outgrowing cell as the central cell of the cystocarp, and grow into short-jointed abundantly-branched cell-filaments. By this means is produced a more or less highly-developed tuft of filaments, the filaments of which either remain individually free (*Peyssonelia*, *Cruoriopsis**), or are held together

* With regard to *Cruoriopsis* I have formerly stated (Sitzungsb. d. niederrh. Gesellsch. für Natur- und Heilkunde zu Bonn, 1879, p. 377) that after the conjugation of the "fertilization-tube" of a "procarp" without a trichogyne, the other cells of the latter become directly converted into spores. I must now correct this statement in this respect, that after the conjugation of the ooblastema-cell with an auxiliary cell (the above-mentioned cell of the trichogyneless "procarp"), the former cell sprouts as the central cell of the cystocarp, and gives origin to one or two short lateral branches of from one to three cells. These lateral branches take a direction parallel to the erect thallus-filament, so that of two lateral branches, the one regularly grows upwards and the other downwards. Both together then precisely present the aspect of a trichogyneless "procarp," with the middle cell of which the "fertilization-tube" has conjugated, just as I formerly interpreted the observed facts. After I had found the key to the processes in the fructification of the Florideæ by the comparative investigation of numerous individual forms, it became comparatively easy to fathom and establish as above the development of *Cruoriopsis*, the complete elucidation of which in detail, for a time, presented many difficulties.

as a closed cell-body by a common dense and tenacious gelatinous envelope (*Cruoria, Polyides, Dudresnaya, Dumontia, Glœosiphonia, Calosiphonia*). The individual sections of this tuft of filaments reach maturity sometimes simultaneously, sometimes at different times; but all the filaments of these sections develop their superior cells, or even almost the whole of their individual cells, into spores, which, in the latter case, directly envelop the central cell, which alone remains sterile (*Dumontia*), but in the former case are separated from this central cell by a more or less abundant mass of sterile cells, the so-called *placenta* of systematic authors (*Glœosiphonia, Dudresnaya*).

Here, then, the conjugation of an ooblastema-cell with an auxiliary cell leads finally to the development of a complex of spores, which, as an independently individualized cell-body, is sometimes surrounded with a special envelope by the surrounding thallus-tissue, sometimes enclosed in the thallus-tissue without any such envelope. Such a cell-body shows exactly the habit of a distinct independent spore-fruit, and is accordingly regarded as a distinct independent cystocarp. But, in accordance with what has been stated, the origin of such a cystocarp is quite different from that of the individual cystocarp of the Helminthocladieæ and Gelidieæ. In the latter the fertilized ovicell develops into an individual spore-fruit (cystocarp), as in the Mosses; but in the present case the ovicell grows into a branched system of offshoots, which develops numerous individual cystocarps on its branches, analogous to the numerous spore-fruits of the branched ferns.

These individual cystocarps in the Squamarieæ frequently come so near together that they can hardly be distinguished from each other as independent fruit-bodies. Thus in *Cruriopsis cruciata*, Duf., numerous cystocarpia, in the form of short chains of spores, which are generally interrupted in the middle by the sterile central cell, lie close together among the erect filaments of the thallus. In *Peyssonelia* the individual closely approximated cystocarps form tufts of branched filaments, the branches of which arrange themselves among the erect parallel filaments of the nemathecia, and develop into separate chains of spores; so that here also, at the commencement of the maturity of the spores, numerous chains of spores are lodged close to each other among the erect sterile fibres. These chains of spores consequently appear as the essential, independently individualized fruit-bodies, just as in *Cruoriopsis*, and accordingly, just as in *Cruoriopsis*, they have been described as the true cystocarps, and distinguished, under the name of *cystidia*, as a special form of cystocarpia.

4. *Corallineæ.*

In the Squamarieæ parallel thallus-fibres with carpogonial branches and auxiliary cells also often stand in great numbers close together (*Petrocelis, Cruoriopsis*). This is the case to a far greater degree in the Corallineæ, which moreover, in other respects, closely approach the Squamarieæ.

In these Corallineæ the formation of the fruit begins with the development of a closed stratum of long parallel thallus-fibres. The penultimate cell of these threads becomes enlarged, and develops (usually in a characteristic manner) one or several unicellular lateral branches, which place themselves beside the terminal cell. But in a larger or smaller number of these parallel cell-fibres bicellular side branches are also developed on this penultimate cell, while the terminal cell becomes developed into the carpogonium and puts forth a long trichogyne. The penultimate cells of all these parallel cell-fibres, however, become auxiliary cells.

Of the numerous carpogonial branches which are in this way placed close together only a small number attain complete development and fertilizable maturity, the majority being aborted (and this is observed in the same manner also among the Squamarieæ, *e. g.* in *Petrocelis Ruprechti*, Hauck). But on the fertilization of a perfectly developed carpogonium the fertilized ovicell enters (at least as I think I may assume, from the analogy of the other Florideæ*) into a conjugation with the nearest auxiliary cell; the conjugation-cell thus formed then puts forth several processes, which immediately conjugate with the auxiliary cells in their immediate neighbourhood; and this process of conjugation is then further continued laterally to the following auxiliary cells until a tolerably extended layer of auxiliary cells is amalgamated into a distinct large disciform conjugation-cell. At the margin of this disk several offshoots are then pushed forth; these become divided by a transverse dissepiment, and thus give origin to so many separate spore-complexes.

* This point in the development of the fruits of the Corallineæ (the exact investigation of which, as is well known, is rendered remarkably difficult by the small size of their cells) I have hitherto been unable to establish directly.

Moreover, not only in the Corallineæ, but also in many other Florideæ with small-celled, closely packed cellular tissue, there are special difficulties opposed to the exact ascertainment of the fate of the fertilized ovicell, which render these investigations *extremely* troublesome and tedious, and greatly hinder any certain decision. From this also are to be explained the numerous divergent statements which occur in literature, and which differ essentially from the present explanation precisely in this point.

In detail this process shows many and various peculiar variations in the different forms of the Corallineæ ; but in general its course is that the ooblastema-fibres of the fertilized ovicell conjugate successively with several approximated auxiliary cells, until, but only after the last conjugation, a sprouting forth of the conjugation-cell is set up, which develops a complex of spores (here usually a single chain of spores). The close union of the whole of the thallus-fibres, which bear auxiliary cells and carpogonial branches, has, however, as its consequence, that the whole of the spore-complexes which originate in consequence of the above repeated conjugations are placed very close together and form a connected group, which rises as a single whole upon the thallus, and therefore is to be regarded as an individual cystocarp. But according to its development this individual cystocarp is essentially different from the individual cystocarp of the Helminthocladieæ and Gelidieæ, and rather approaches more nearly to the group of isolated cystocarps which, in the Cryptonemieæ and Squamarieæ, proceed from the ooblastema-threads of a single fertilized carpogonium.

5. *Ceramieæ, Rhodomeleæ, Sphærococceæ, Rhodymenieæ, and Gigartineæ.*

Among the Cryptonemieæ already referred to, *Glœosiphonia* presents the peculiarity that a single, short branch-filament of the thallus-tissue develops its penultimate cell into an auxiliary cell, whilst the lowest cell of this branch develops laterally a short, three-celled carpogonial branch. The carpogonium and auxiliary cell are thus in this case formed as a pair, and close together*, so that it is the simplest thing possible for the ooblastema-fibres of the fertilized carpogonium to meet with the auxiliary cell belonging to it, in order to unite with the latter. In fact, in *Glœosiphonia* the single sparingly branched ooblastema-thread usually grows directly to its auxiliary cell and conjugates with it, unless the ooblastema-thread of a neighbouring earlier fertilized carpogonium has already preoccupied it.

Such a condition must, however, be greatly facilitated when the auxiliary cell is brought still nearer, or into the close vicinity of the carpogonium. The ooblastema-thread may then be reduced to a very small length or completely suppressed, as the fertilized ovicell can enter into direct union with the contiguous auxiliary cell.

* Such groups of carpogonial branches and auxiliary cells, which arise as independent wholes upon the thallus of the parent plant, are indicated in the sequel as fruit-rudiments or *procarpia*.

This is really the case in a very great number of Florideæ, nay, I believe I may assert that in the majority of the Florideæ in general (in the numerous families of the Ceramieæ, Wrangelieæ, and Rhodomeleæ, the Chylocladieæ, Rhodymenieæ, and Sphærococceæ, and lastly, the Gigartineæ) the further development of the fertilized ovicell is effected in this manner.

A short, frequently three- or four-celled carpogonial branch is attached laterally to a thallus-fibre, and is at the same time curved in such a manner that the carpogonial cell is directly applied against the neighbouring auxiliary cell, or, at least, can conveniently reach it by means of a short lateral process. Not unfrequently, also, the direct contact of these two cells is brought about by the auxiliary cell itself extending towards and closely applying to the carpogonial cell a lateral diverticulum or conjugation-process (figs. 31, 35, 38). In other respects, however, the position of the carpogonial branch and the auxiliary cell in the tissue of the thallus may be very variable.

1. These organs are most easily observed in many Ceramieæ and Wrangelieæ.

Thus in *Pterothamnion plumula*, Näg. (fig. 35), for example, one of the terminated (*begrenzte*) lateral branches of the thallus bears, inserted at one side of its basal cell, a four-celled, short-jointed carpogonial branch, which bends its apex towards the upper surface of the branch, while, on the opposite side of this basal cell, a unicellular branch develops into the auxiliary cell, which also curves its apex towards the upper surface of the whole branch of the thallus, and thus comes into direct contact with the carpogonial cell. In other cases a shorter or longer terminated cell-filament bears near the apex on a joint-cell a short (usually three- or four-celled) carpogonial branch, while from the same joint-cell several other, one- or more-celled lateral branchlets issue (fig. 34). Sometimes this joint-cell itself becomes the auxiliary cell (*Lejolisia mediterranea*, Born., according to Bornet); in other cases one of the unicellular lateral branchlets which issue, besides the carpogonial branch, from the joint-cell develops its cell into the auxiliary cell (*Ptilothamnion pluma*, Thur., and *Spondylothamnion multifidum*, Näg., according to Bornet); or an auxiliary cell originates on each side from the unicellular lateral branchlets (*Spermothamnion*, certain species of *Callithamnion*, fig. 34). In many species of *Callithamnion* the cell-filament which bears the carpogonial branch and the two auxiliary cells on one of its joint-cells is not terminated, but grows on at the apex without alteration for a longer or shorter time (*C. corym-*

bosum, Lyngb., &c.). In *Griffithsia* the penultimate joint-cell of a terminated small-celled branch-filament bears laterally two short two-celled branchlets, the lower cell of which produces laterally a four-celled carpogonial branch, and then itself becomes developed into the auxiliary cell. In *Ceramium*, on the other hand, the joint-cell of a still-growing branch develops laterally a two-celled branch, the lower cell of which becomes the rather large auxiliary cell, but also develops laterally not only one but two four-celled carpogonial branches.

2. The arrangement of these parts in the multicellular offshoots of the Rhodomeleæ is still more complicated and difficult of recognition.

In *Polysiphonia*, as is well known, the individual joint-cell first of all develops a whorl of branch-cells, which, closing together firmly at the sides, surround the central cell with a closed rind, which, by the continued division and branching of its cells, becomes more or less thickened according to the species. Here the carpogonia are now usually formed on special, terminated, lateral offshoots. On one of the superior joint-cells of such an offshoot one of the "marginal cells," and indeed the last-formed unpaired marginal cell, grows into the four- or five-celled carpogonial branch. Its lowest cell becomes the auxiliary cell, but the small-celled apex of the branch bends upwards, so that the carpogonial cell touches the auxiliary cell with the lower angle (figs. 36, 28); while, in the simplest cases, from the auxiliary cell itself a unicellular, sterile, lateral branchlet proceeds downwards. At the same time the other "marginal cells" of the above joint-cell divide and branch repeatedly, and thus produce a small cell-body, which encloses the carpogonial branch together with the auxiliary cell, and, as it rises as a whole distinctly on the thallus, may appropriately be characterized as a *procarpium*.

In other species of *Polysiphonia* and other genera of the Rhodomeleæ this procarpium appears still more complicated, because, besides the terminal carpogonial branch, one or two lateral branchlets issue from the auxiliary cell, and these sometimes branch abundantly and give origin to a many-celled cell-complex, which in the fertilizable procarpia conceals the auxiliary cell, and may easily be interpreted (as, indeed, has hitherto been generally the case) as a "group of carpogenous cells" (*Chondria tenuissima*, Ag.). Perhaps, also, in some of these forms a plurality of auxiliary cells may be formed in the individual procarpium; but I have hitherto never been able to demonstrate such a case with certainty.

3. Among the Chylocladieæ the carpogonial branches in *Chylocladia kaliformis*, Hook., are usually very early formed

near the still-growing apex (fig. 29). On one of the large cells composing the wall of the tubular thallus-joints a four-celled branch is developed upon the outer side, and this curves in a characteristic fashion and develops its apical cell into the carpogonium (figs. 30, 33). But over this carpogonial cell larger covering cells curve from both sides (more rarely from one side, fig. 31), which are segmented off from the two bordering cells of the thallus-wall, and bend over in such a manner that they are applied to the carpogonium by their extended margin, the conjugation-process (fig. 32). These two cells represent the auxiliary cells, of which, however, after the fertilization of the carpogonium, only a single one, as a rule, arrives at further development.

4. As the clearest example of the structure of the female sexual organs in Sphærococceæ the genus *Nitophyllum* may here be cited. In the species of this genus (e. g. *N. venulosum*, Zan.) the formation of the sexual organs proceeds from a single cell of the originally always one-layered thallus. This separates off towards the under surface of the flat thallus several branch-cells, which further branch in various ways; but superiorly it regularly forms two branch-cells, one of which develops a short sterile pluricellular branch, while the other, besides a terminal sometimes divided cell, develops a three- or four-celled small-celled branch, the terminal cell of which becomes the carpogonium. This branch bends from its point of insertion in such a manner along the supporting cell, that its terminal cell is applied to the opposite end of the supporting cell, and then from the apex of this terminal cell the short trichogyne is extended outside through a fissure between the neighbouring cells. This supporting-cell becomes the auxiliary cell.

5. Among the Rhodymenieæ, for example in *Plocamium coccineum*, Lyngb., a short three-celled lateral branch, the terminal cell of which becomes the carpogonium, is formed supplementarily upon one of the larger cells within the locally enlarging small-celled external cortical layer (fig. 37). This short branch bends along the simultaneously enlarging supporting cell and then extends the trichogyne externally from the apex of the terminal cell through the overlying cellular tissue. This mother-cell of the carpogonial branch, however, develops at its upper end a lateral diverticulum, a conjugation-process, until it comes in contact with the carpogonial cell, and forms for its part the auxiliary cell (fig. 38).

6. Finally, of the Gigartineæ, *Gigartina Teedii*, Lmx., and *Chondrus crispus*, Stackh., likewise present, within the small-celled external cortical layer of the thallus, small secon-

dary lateral branchlets, formed upon certain cells of the vegetative cell-filament, and these curve in a characteristic manner so that their terminal cell approaches very closely with one of its corners to the supporting-cell, which at the same time also greatly increases. This terminal cell becomes the carpogonium, the trichogyne of which is much enlarged, but in a variable manner, at its base *, before it extends itself exteriorly as a thin capillary process through the small-celled cortical tissue; but the supporting-cell of the whole carpogonial branch becomes the auxiliary cell.

Different as the arrangement of the carpogonia and auxiliary cells may be in all these individual cases, the forms in question nevertheless agree in the mode of further development of these organs after the fertilization of the carpogonium has taken place.

First of all the ventral part of the carpogonium becomes segmented off as the ovicell. In the next stage of development this ovicell appears emptied of protoplasm, except a very small residue (it was but seldom that I found more abundant plasma-masses retained in the ovicell, *e.g.* in *Callithamnion plumula*, Näg.), but the closely approximated auxiliary cell appears very full of contents and at once commences a new and rapid growth.

That in this case the protoplasm (with the cell-nucleus) of the fertilized ovicell (or at least a part of this protoplasm with the cell-nucleus) migrates into the auxiliary cell can hardly be doubted, as the ovicell empties itself to a greater or less extent; but the mode of this transference I have hitherto been unable to ascertain with certainty in its details.

In *Glœosiphonia* open conjugation takes place between the ooblastema-cell and the auxiliary cell; but after the migration of the protoplasm of the former cell, the latter cell completely closes the aperture of conjugation by the new formation of a portion of membrane, so that after the conjugation has been effected scarcely any trace of it is to be detected (fig. 12). If in this case the protoplasm of the ooblastema-cell passed very rapidly over into the auxiliary cell, it would depend entirely upon chance whether one could succeed in fixing the two cells during the conjugation, and so bring the latter to demonstration; but with the slower course that the process really follows it is not very difficult to find such stages of conjugation in fixed material.

In the forms now under consideration I believe we must

* Such enlargements of the base above the neck of the trichogyne also occur among many other Florideæ with densely packed cellular tissue (see figs. 33 and 38).

assume that the process of conjugation takes place in exactly the same way as in *Glœosiphonia*, but that it is effected much more rapidly than in that genus, so that direct observation of the conjugation-stages is perfectly a matter of chance. Notwithstanding all my endeavours, however, chance has not hitherto been favourable to me in the present forms (which are also difficult of investigation in other respects). Nevertheless at present I would not doubt of the occurrence of a true conjugation of these two cells.

It is true that it is quite possible that there may be a migration of the protoplasm (with the cell-nucleus) of the ovicell into the auxiliary cell *without* complete conjugation of the two cells (as in the fertilization of the Phanerogamia *, of many Peronosporeæ [*Phytophthora*, *Peronospora* †], Erysipheæ, &c.) through the separating membranes ‡, that is fine pores (*not* micellar interstices) of these membranes. But the analogy of the nearly allied Floridean genera, which distinctly show a complete conjugation of these two cells, appears to me still too weighty to allow me to decide in favour of this latter assumption so long as we have no *certain* demonstration upon a readily accessible object of the non-occurrence of conjugation §.

After this migration of the protoplasm (that is, of the cell-nucleus) of the fertilized ovicell into the auxiliary cell, the latter commences a very rapid new growth, which leads to the development of a fruit-body. This growth, however, takes place in the above-mentioned individual groups in very different manners, and the consequence of this is the very different structure and habit of the different forms of fruits ||.

* Strasburger, 'Befruchtung und Zelltheilung,' p. 58; 'Bau und Wachsthum der Zellhäute,' p. 247; Sitzungsber. d. Ges. f. Nat.- und Heilk. zu Bonn, December 4, 1882.

† De Bary, 'Beiträge zur Morphologie und Physiologie der Pilze,' 4te Reihe, pp. 72, 73.

‡ See also Pringsheim's description of the passage of amœboidal plasma-masses through the membrane of the antheridial tube of *Achlya colorata* (Sitzungsb. Akad. Wiss. Berlin, 1882, p. 870).

§ The fact that I have myself for a long time endeavoured in vain to demonstrate such a conjugation in the easily accessible species of *Callithamnion*, *Spermothamnion*, and *Griffithsia*, would certainly seem to lend support to the notion that here there is really no conjugation of the cells in question.

|| To enter in more detail into the further development of the cystocarp in the various genera of Florideæ would lead us too far. But one of these forms of fruit needs special mention, as it has been affirmed to have a parthenogenetic origin.

Thus while in the majority of the species of *Callithamnion* the spore-complex into which the single auxiliary cell grows constitutes a dense and close tuft of filaments, a close cell-body (*favella*), this spore-complex in

It is, however, a very common phenomenon that the developing auxiliary cell first of all puts forth a rather large diverticulum, and then separates it off as an independent cell. From this cell, as the central cell of the entire fruit-body, numerous side-branches then sprout forth, which ramify more or less, and finally produce, from single or numerous cells of their whole system of ramifications, individual naked carpospores. The mother-cell of this central cell, the former auxiliary cell, however, sometimes remains undivided, sometimes develops only a few side-branches, which spread out laterally and attach the developing spore-fruit to the branch of the thallus (*Callithamnion corymbosum*, Lyngb. &c.), and sometimes branches more abundantly, and forms with its

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Callithamnion versicolor, Draparnauld (according to Bornet, 'Etudes phycologiques,' p. 70, note 4, identical with *C. seirospermum*, Harv. [=*Seirospora Griffithsiana*, Harv.], *C. stipitatum*, Näg., and *C. hormocarpum*, Holmes), forms a loosely branched tuft of filaments, exactly like the tufts of *Seirospora*, which in this species originate by metamorphosis of the apices of the branches. These "seirosporiform favellæ," according to Falkenberg ("Meeresalgen des Golfes von Neapel," in Mitth. der Zool. Station zu Neapel, i. p. 253), originate by parthenogenetic development of the auxiliary cells, the carpogonia being either early aborted or not developed at all, while the auxiliary cells belonging to them continue their development notwithstanding. From my own observation, however, I cannot agree with this interpretation of the facts. Certainly in *C. versicolor*, Drap. (as in many other Florideæ), there are often aborted carpogonia, the auxiliary cells belonging to which persist. But these auxiliary cells do not grow into parthenogenetic spore-fruits, but simply become small sterile thallus-cells in the same way as in other species of *Callithamnion*; and these "seirosporiform favellæ" originate from auxiliary cells, the carpogonial branch belonging to which develops a normal carpogonium with a well-developed trichogyne. Evidently such carpogonia were accidentally no longer persistent in the specimens of the plant investigated by Falkenberg.

Moreover Falkenberg (*loc. cit.*) cites the present plant not as *C. versicolor*, Drap., but as *C. corymbosum*, J. Ag., var. ? *seirosporum*, and Berthold ("Vertheilung der Algen im Golf von Neapel," in Mitth. d. Zool. Stat. iii. p. 515) has quite recently united the same plant with *C. corymbosum*, Lyngby (J. Ag. Sp. Alg. iii. p. 40). From this latter species, certainly very similar in habit, in which seirosporæ are entirely wanting (and which, moreover, occurs with *C. versicolor* in the Bay of Naples), *C. versicolor*, Drap., is distinguished not only by the form of the cystocarps and antheridia (to which attention has already been called by Bornet, *loc. cit.*), but also by the structure of the individual thallus-cells. In *C. versicolor*, Drap., the sterile thallus-cells are always uninucleate, while in *C. corymbosum*, Lyngby (with the exception of the youngest cells) they are always multinucleate (see my statements in the Sitzungsb. d. niederrh. Ges. f. Nat.- u. Heilk. zu Bonn, June 7, 1880, p. 125 [p. 4 of the separate impressions]).

So far as I know, a parthenogenetic, *i. e.* apogamic, origin of the spore-fruits has never been described in any other Florideæ.

ramified lateral branches, in conjunction with the neighbouring thallus-tissue, a very variously formed envelope around the developing spore-tuft.

Sometimes, indeed, the auxiliary cell enters upon a perfectly different course of development; as, for example, in *Chondria tenuissima*, Ag. In this species, namely, the auxiliary cell at the period of fertilizable maturity bears, besides the terminal carpogonial branch, two very richly ramified lateral branchlets, which coalesce closely, to form an elongated cell-complex, which pushes the carpogonial branch somewhat to one side. After fertilization the auxiliary cell then increases in size, and, conjugating with the nearest cells of that cell-complex, becomes developed into a large, branched, multinucleate cell, which bears, attached to its outer surface, numerous two- or three-celled sterile cell-filaments, the final ramifications of the cell-filaments of that cell-complex. Then at the superior free extremity of this conjugation-cell, which (so far as I could make out) is not here segmented off as an independent cell, several lateral branches sprout forth, one after the other, and these, ramifying abundantly, form a short stumpy tuft of sporigerous filaments. I have no doubt that similar processes will be observable in other Rhodomeleæ.

Lastly, the Gigartineæ (*Gigartina*, *Chondrus*) call for special notice. In these forms the single auxiliary cell becomes itself the central cell of the spore-fruit. From its whole surface cell-filaments shoot forth in all directions like the rays of a star, and diffuse themselves, branching abundantly, in the surrounding thallus-tissue*.

In *Gigartina* these branched filaments finally develop single naked carpospores from the individual cells of the filaments. In *Chondrus*, on the other hand, numerous cells of these filaments enter into close connexion with individual neighbouring cells of the sterile thallus-tissue by the formation of a pit, and then, from individual cells of these filaments by repeated division, there originate complexes, each consisting of four cells, which, for their part, give origin each to a naked carpospore. Consequently, even within so natural a group as the Gigar-

* Hence the offshoots of the auxiliary cell in the present series of forms, the Ceramieæ, Rhodomeleæ, Sphærococceæ, Rhodymenieæ, Gigartineæ, and § V. appear perfectly analogous to the offshoots of the fertilized carpogonial cell, which are indicated in the preceding as *ooblastemas*. It may therefore be advisable to contrast them as *secondary ooblastemas* or *meta-ooblastemas* with those primary ooblastemas. This appears to be particularly indicated if we regard (as I believe we are bound to do, see under § V.) the action of the fertilized carpogonial cell (*i. e.* the ooblastema-cell in *Glœosiphonia* and other similar species) upon the auxiliary cell as a second act of fertilization, and interpret the fertilized auxiliary cell therefore also as a fertilized ovicell.

tineæ, there is a repetition of the same phenomenon which has been previously described in the series of forms of the Gelidieæ and Cryptonemieæ, namely, that in certain forms the ramified ooblastema-filaments produce spores directly from their cells; whilst in others these individual cells enter into connexion with the cells of the surrounding sterile thallus-tissue, and thus the formation of multicellular complexes of spores is superinduced*.

[To be continued.]

II.—*Note on the Structure of the Skeleton in the Genera* Corallium, Tubipora, *and* Syringopora. By H. Alleyne Nicholson, M.D., D.Sc., Regius Professor of Natural History in the University of Aberdeen.

Some time ago I published a short paper on the structure of the skeleton in *Tubipora*, with special reference to the relations of this genus to the Palæozoic *Syringopora* (Proc. Roy. Soc. Edinb. 1880–81, p. 219). The general conclusion to which I was led by a comparison between these two types was that, though undoubtedly similar in aspect, they were not really related to one another. The grounds upon which I based this conclusion were the following:—

(1) "In the first place, there is the very important and remarkable difference in the minute structure of the calcareous skeleton in the two types in question. In *Tubipora* the corallum is made up of fused † calcareous spicules, which are so disposed as to give rise to a universally distributed system of minute canaliculi or tubuli, which open on both the outer and inner surfaces of the skeleton by well-marked apertures. The size of these tubuli is comparatively so great that it is quite impossible that their presence could be overlooked in thin sections of *Syringopora*, if they really existed in this genus. On the other hand, the skeleton of *Syringopora*, as

* I have hitherto found among the Gigartineæ nothing analogous to the third case, namely, that the cells of the ooblastema-filaments conjugate with individual cells of the thallus, and then these thallus-cells develop into multicellular spore-complexes.

† Mr. Hickson has rightly pointed out that the term "fused" as applied to the spicules of *Tubipora* might lead to some misconception, as actual amalgamation of the spicules does not take place. The spicules, on the other hand, are united with one another closely by their sides or projecting points, and it was to indicate this union only that I employed the term "fused" in my former paper.

regards its minute structure, is quite compact, and shows no signs whatever either of being penetrated by a system of tubuli or of being formed by the fusion of ectodermal spicules."

(2) Secondly, I was not able to recognize in *Tubipora* any thing which appeared to me to be truly of the nature of "tabulæ;" nor did I regard the "axial tube" of *Tubipora* as truly homologous with the funnel-shaped tabulæ of *Syringopora.*

(3) I pointed out that the corallites in *Syringopora* are provided with a well-developed system of septal spines, which are extremely similar to the septal spines of various species of *Favosites* and *Porites,* whereas I had been unable to detect similar septal spines in the corallites of *Tubipora.*

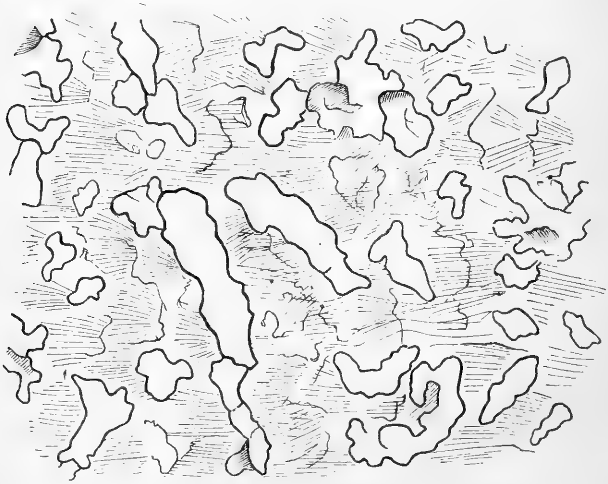
Recently an elaborate paper has been published by Mr. Sydney J. Hickson "On the Structure and Relations of *Tubipora*" (Quart. Journ. Micr. Sci., Oct. 1883). In this memoir Mr. Hickson comes to the conclusion that the genus *Tubipora* is, after all, closely allied to *Syringopora,* and that the latter is really an Alcyonarian, the Favositidæ also being referable to the Alcyonaria. In formulating this conclusion, Mr. Hickson passes in review the three points mentioned above which had led me to believe that *Syringopora* and *Tubipora* were not really related to one another; and I should wish, therefore, to make one or two remarks on each of these points.

In the first place, as to the wide difference in the minute structure of the corallum in these two genera, Mr. Hickson remarks that "it is difficult to see why this difference should be considered of any great morphological importance. The size of the pores or 'tubuli,' as Prof. Nicholson calls them, varies considerably in the different regions of the corallite, being at the younger ends much larger than they are at the older ends, so that it is evident that as the corallite grows older the tubuli have a tendency to be filled up, and a still further continuation of this process would make the wall of the corallite quite aporous. I have no evidence to prove that the complete filling-up of these perforations in the walls ever does occur in *Tubipora*; but should an example be found in which this has occurred, I should certainly not consider it sufficient reason for the formation of a new genus or even a new species. That the skeleton of *Syringopora* 'shows no signs of being formed by the fusion of ectodermal spicules' is not to be wondered at, as we possess no means of studying either the development or the growth of the skeleton of this form, since the delicate growing ends would be broken down and destroyed; and even in recent genera (such as *Corallium,* Lacaze-Duthiers), in which the skeleton is known by an examination of its growth to be composed of fused spicules, no evidence of them can be seen in thin transverse section through the hard parts."

With regard to Mr. Hickson's statement that it is "difficult to see" why the difference between the spicular skeleton of *Tubipora* and the compact skeleton of *Syringopora* "should be considered to be of any great morphological importance," I can merely say that this is clearly a matter of opinion. For my own part I find it difficult to see why this distinction as to the minute structure of the corallum should *not* be considered as of great morphological importance; and some investigations that I have recently been carrying out have very much confirmed me in this opinion. The hypothesis, on the other hand, that possibly an aporous form of *Tubipora* may be in future discovered, would not lead me to disregard the known structure of the actual form of *Tubipora*. Moreover it is not only that the skeleton of *Syringopora* does not show "signs of being formed by the fusion of ectodermal spicules," but that it does show signs of having a structure very similar to that of various undoubted recent Zoantharians, and quite unlike that of any known recent Alcyonarian. Again, it is not the case that "we possess no means of studying either the development or the growth of the skeleton" of *Syringopora*, "since the delicate growing ends would be broken down and destroyed." On the contrary, as regards the growth of the skeleton, any good collection of Palæozoic corals contains perfect colonies of *Syringopora*, in which the growing extremities of the tubes are as well preserved as we have any ground for supposing that they would be were the coral a recent one; and an examination of these growing ends shows that they do not differ in minute structure from what is found in the older parts of the tubes.

Lastly, as regards the structure of the skeleton in *Corallium*, Mr. Hickson has fallen into error, and his argument, in reality, points in the opposite direction. He argues, namely, as I understand him, that *Syringopora* may have really had a spicular skeleton, because in the recent genus *Corallium*, though we know from an examination of its growth that the skeleton is really composed of fused spicules, "no evidence of them can be seen in thin transverse section through the hard parts." As a matter of fact, however, such spicules were shown to exist in sections of the skeleton of *Corallium* by Lacaze-Duthiers, and were both described and figured by Kölliker ('Die Bindesubstanz der Cœlenteraten,' p. 146, Taf. xvi. fig. 9). It is not necessary, however, to quote authorities on such a point, as I have never had any difficulty in demonstrating the presence of the component spicules in any thin section of the skeleton of *Corallium* that I have prepared. The annexed sketch of part of a longitudinal section of a branch of *Corallium* will show that the skeleton is made up of spicules of the ordinary type of these structures amongst the Alcyonarians, the outline of the spicules being sometimes indistinct, and the interspaces between them being occupied by a peculiar crystalline tissue. Essentially similar phenomena are seen in transverse sections of the skeleton of *Corallium.* I may add that I have also always found it possible to recognize the presence of the component spicules of the corallum even in the genus *Isis*, though the fusion of the spicules is here much more complete than it is in *Corallium.* In fact, the spicules in *Corallium* are not, strictly speaking, "fused," any more than they are in *Tubipora.*

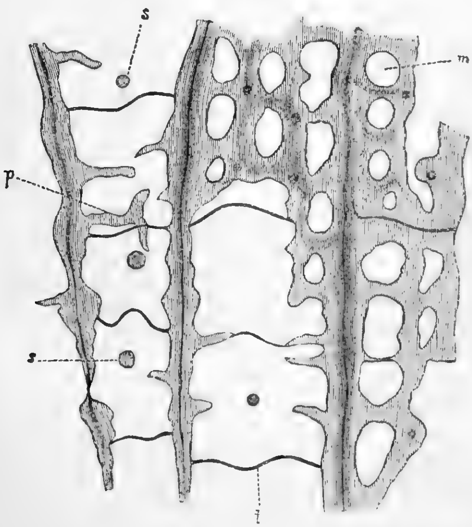
Fig. 1.



Part of a longitudinal section of *Corallium rubrum*, magnified 180 times, showing the spicules of the skeleton united by a crystalline or fibrous matrix, produced by the calcification of the soft interspicular tissues.

In the second place, Mr. Hickson has made a series of very interesting investigations as to the endothecal structures of *Tubipora*, in which he shows that there is a much closer apparent resemblance between the axial tube of this genus and the infundibuliform tabulæ of *Syringopora* than I had been led to believe was the case by examining the specimens of the former genus at my disposal. He also shows that flat tabulæ, sometimes complete and sometimes incomplete, are present in *Tubipora.* These latter structures, which are evidently very variable, I have not succeeded in detecting, but I do not doubt their existence. I cannot, however, admit that the presence of flat tabulæ in *Tubipora* affords any strong argument for concluding that this genus is nearly related either to *Syringopora* or to any of the Favositidæ. Nor, indeed, can I admit that tabulæ, in themselves, are any guide whatever to the zoological position of any calcareous skeleton, whether recent or extinct, since these structures are known to occur in Zoantharians (*Pocillopora* &c.), Alcyonarians (*Heliopora*), Hydrozoa (*Millepora*), and Polyzoa (*Heteropora*). I cannot, further, allow Mr. Hickson's statement (*loc. cit.* p. 21), that "tabulæ are quite unknown amongst the Poritidæ," to pass without pointing out that, in making it, he has fallen into error. Thus Dana, long ago, showed that "tabulæ," essentially similar to the tabulæ of *Favosites*, occur in the genus *Alveopora*, and figures of these were given by this dis-

Fig. 2.



Part of a longitudinal section of the corallites of *Porites clavaria*, Lam. (Recent), enlarged eleven times. *t*, tabula; *s s*, septal spines, cut across near their bases; *p*, septal spine, projecting into the visceral chamber; *m*, mural pore.

tinguished observer in support of his statement. It is, moreover, easy to demonstrate by means of thin sections that "tabulæ," in all essential points quite like those of the Favositidæ, occur in species of the genus *Porites* itself. Thus, I find them to be well developed in *Porites clavaria*, Lam., and to be even more numerously developed in *Porites astrœoides*, Lam. I annex a sketch of a thin longitudinal section of some of the corallites of *Porites clavaria*, to show the tabulæ (fig. 2). As I purpose, however, to return to this subject at greater length, I shall say nothing further about it here, merely adding that a comparison between the accompanying section of *Porites clavaria*, Lam., and a corresponding section of such a species of *Favosites* as *F. hemisphœrica*, Yand. & Shum., will show how striking is the structural agreement between the two.

Finally, as regards the existence of septa, Mr. Hickson has described in *Tubipora* certain septiform structures which he finds occasionally to unite the axial tube to the theca; and he also mentions that "occasionally individual spicules will project out radially into the cavity of the corallite in a manner exactly similar to the so-called 'septa' of *Syringopora*." I regret that I cannot accept either of these structures (both of which I have seen) as being at all of the nature of true septal spines, or as being in any way properly comparable with the vertically arranged spiniform septa of *Syringopora*. The septal spines of *Syringopora* are, on the other hand, properly comparable, in my opinion, with the septal spines of such Zoantharians as *Porites* and *Alveopora*.

I need hardly add, finally, that I find myself compelled to dissent entirely from Mr. Hickson's conclusion, that "the evidence at our command tends to prove that the Favositidæ are really Alcyonarians, and that *Syringopora* is also an Alcyonarian allied to *Tubipora*." On the contrary, I think the evidence at our command is sufficient to prove that the Favositidæ are Zoantharians closely allied to the Poritidæ, and that *Syringopora*, instead of being an Alcyonarian and allied to *Tubipora*, is a Zoantharian and allied to *Favosites*. On this last point I hope shortly to publish some interesting additional evidence that I have recently obtained.

III.—*On the* Mantis metallica *of Westwood.*

By J. Wood-Mason.

The beautiful species of the Orthopterous family Mantodea, which was described and figured nearly forty years ago by Prof. Westwood in his 'Arcana Entomologica,' under the name of *Mantis metallica*, would appear still to be unique, or at any rate very rare, in European collections, no specimens of it having been seen either by De Saussure or by Stål, the latter of whom makes not the slightest allusion to it in his 'Systema Mantodeorum,' while the former is able to do no more than place it next after his *Odontomantis javana*, one of the two species to which it turns out to be most nearly affined.

A second specimen has at last been obtained in the district adjoining that from which the first was received. It was captured in September 1881, on Nemotha, a peak of the North Cachar hills, which rises to the height of 3336 feet, by my native collector, by whom it was forwarded alive to Silchar, where I happened at the time to be stationed.

The species belongs to the subfamily Harpagidæ of Stål's system, and is very closely allied to *Odontomantis javana*, Saussure, and to *Antissa pulchra*, Fabr. It differs from the former, but not from the latter, in the discoidal vein of the wings being branched; from the latter, but not from the former, in the transverse ridge of the clypeus being angulated; and from both of these species in its greater robustness, in its more firmly chitinized integument, and especially in the form of the prothorax; on which last account I propose for its reception a new subgenus, which may be thus named and characterized :—

NEMOTHA, subgen. nov.

Pronotum robust and tolerably broad, strongly constricted posteriorly; the portion of it in front of the constriction oval; the disk of its posterior lobe slightly inflated on each side of the median ridge at the anterior end. *Clypeus* transversely elevated into a strongly angulated ridge. *Frontal shield* obtuse-angular at base, with the angle but slightly projecting; its disk furnished with two short and widely separated ridges. *Discoidal vein* of the wings branched.

Nemotha metallica.

Mantis metallica, Westwood, Arcana Entomol. ii. p. 54, pl. 62. fig. 3, ♀.

♀. Head, legs, margins of the pronotum as far back as the constriction and a band running from the margins across the supracoxal groove, and the under surface shining black, with blue reflections like the blue-black paper used to cover pill-boxes, with all the articular membranes, two streaks on each eye, the middle two fourths of the first joint of the fore tarsi (this paler and greenish), a thick bracket-shaped mark at the posterior end of the second, third, fourth, fifth, and sixth abdominal sterna, all the soft and membranous parts of the thoracic sterna, and a short streak on the extremity of the dorsal crest of the four posterior femora pale turquoise-blue; head between juxtocular bosses from vertex-line to ocelli, and the disk of both lobes of the pronotum yellow, of the shade of autumn leaves; tegmina yellow-green, clouded with reddish fuscous, and narrowly edged in front with jet-black, their anal area red at the very base, beyond which the veins are red and the meshes smoky; wings with base and anterior area rather opaque, red, passing into yellow at extremity, as to the rest black-smoky with purple reflections; abdomen above dark steel-blue, tipped with yellow.

Head thicker than in *A. pulchra*; forehead marked by five longitudinal grooves; facial shield a little longer, its obtuse-angled basal margin projecting very slightly in the middle line, its disk furnished on each side with a transversely elongated tubercle, representing the ridges present in *A. pulchra*; clypeus transversely elevated into a prominent angulated ridge, from the middle of which a strong longitudinal ridge runs forward to the anterior margin of the part; labrum convex.

Pronotum robust, only about twice as long as broad, traversed along the middle from about the commencement of the posterior fourth of the anterior up to the pair of smooth elevations near the hinder end of the posterior lobe by a coarse ridge; strongly constricted posteriorly; the portion of it lying in front of the constriction having an oval outline, which is slightly broken on each side antero-laterally by a faint flattening or oblique truncation of the edge; the prominent heart-shaped disk of its anterior lobe having two conspicuous oval wrinkled elevations, placed obliquely on each side of the posterior end; its posterior lobe having the muscular impressions at the anterior end large and deep, and the part of the disk between these impressions and the constriction somewhat inflated on each side, so that the groove in which, in the allied species, the ridge is throughout lodged is, in this part of its length, effaced; its finely-denticulate lateral margins a little lamellar.

Organs of flight extending by about one sixth of their length beyond the apex of the abdomen, of the same structure and texture as in *A. pulchra*; the discoidal vein of the wings 3-branched, with one of the branches on one side bifurcate.

Legs longer and slenderer.

Abdomen oval, about $1\frac{1}{2}$ times as long as broad.

Total length of body 28 millim.; length of pronotum 8, breadth of pronotum at dilatation 4·5; length of abdomen 12, breadth of abdomen 8; length of tegmina 22, breadth of tegmina 6; breadth of marginal field 1·5.

The above description was drawn up from the living insect.

Hab. Sylhet and North Cachar hills, Assam.

The specimen has since been compared with the mutilated type in the Oxford Museum by Professor Westwood and myself, and found to agree perfectly therewith. The discrepancy between Westwood's figure and the above description as to the structure of the discoidal vein of the wings is explained by the bad state of preservation of the typical specimen.

IV.—*Notes on the Genus* Gyracanthus, *Agassiz.* By Dr. R. H. Traquair, F.R.S.*

1. *Did* Gyracanthus *possess dorsal spines?*

Although Agassiz himself pointed out that the spines of *Gyracanthus* were not bilaterally symmetrical, inasmuch as one side was more rounded than the other, he nevertheless regarded them as dorsal, and so did people in general, until in 1863 Messrs. Kirkby and Atthey pointed out the probable pectoral nature of some at least of these appendages, the grounds for this conclusion being the conspicuous lateral curvature shown by such specimens, along with the wearing away of the apices, as if they had been subject to habitual attrition at the bottom of the water in which their possessors lived. In 1868 Messrs. Hancock and Atthey returned to the subject †, and, reviewing the extensive series of specimens in the collection of the last-named gentleman, divided them into two categories—first, those with lateral curvature and worn apices, and second, those in which apparently there was

* Read before the Royal Physical Society of Edinburgh, December 19, 1883.

† Ann. & Mag. Nat. Hist. (4) 1868, vol. i. p. 368. In a footnote Messrs. Hancock and Atthey refer to a paper by Messrs. Atthey and Kirkby, entitled "Fish-remains in the Coal-measures of Durham and Northumberland," as having been read before the British Association at Newcastle in 1863, and as containing the first suggestion of the paired nature of these spines. I cannot find this paper in the British Association's 'Proceedings' for that year; and although a paper of the same title is found in the 'Proceedings of the Tyneside Naturalists' Field Club,' it contains no reference to *Gyracanthus*. These original remarks would therefore seem not to have been published.

only an antero-posterior curvature and in which the apex was entire and pointed. The former set, which could also be arranged in pairs, they regarded as *pectoral*, the latter as *dorsal**.

The occurrence of numerous spines of this genus in the Blackband Ironstone of Borough Lee, near Edinburgh, having lately induced me to inquire into the whole subject of *Gyracanthus*, I was surprised to find that, among the numerous specimens which came under my observation from that and other localities in Scotland, there was not one which was bilaterally symmetrical, and which consequently could be assigned to a median position. On this subject I published a few remarks in the 'Geological Magazine' for December 1882. To pursue the subject further it was, however, absolutely necessary to reexamine the specimens in the Atthey collection, now in the museum at Newcastle-on-Tyne. And having recently visited that city, I must here express my cordial thanks to my friends Mr. W. Dinning, Secretary of the Newcastle Natural-History Society, Mr. R. Howse, Curator of the Museum, and Mr. J. Hancock, member of committee, for the kind and liberal manner in which they afforded me every facility for examining the specimens in that remarkable collection of Coal-measure vertebrate remains.

Although I have not seen the original type of Agassiz's *Gyracanthus tuberculatus*, I have no hesitation in referring to it the great majority of the specimens from Newsham in the Atthey collection, and they form, indeed, a most beautiful and instructive series. And as no systematic description has been given of this form since the time of Agassiz, who had only a drawing of a mere fragment to go upon, it will not be out of place to enter somewhat into detail as to the configuration of these spines.

Proceeding first to the consideration of those labelled "pectoral" in the Atthey collection, one very fine example is $15\frac{1}{4}$ inches in length by $2\frac{1}{4}$ in diameter at its widest part near the base; its distal extremity is obliquely truncated or worn off on the anterior aspect, and the whole spine, when looked

* In a paper on *Tristychius*, published in the Ann. & Mag. Nat. Hist. for September 1883, Mr. T. Stock states, with regard to Messrs. Hancock and Atthey's views as to the pectoral nature of certain *Gyracanthus*-spines, that he has "been able to confirm their conclusions by the finding of an interesting specimen containing well-preserved remains of the pectoral arch," and refers to a paper on the subject, read by himself to the Edinburgh Naturalists' Field Club. However, on consulting the paper, now published (Trans. Edinb. Nat. Field Club, vol. i. pt. 2, pp. 50–51), it turns out that the "pectoral arch," in this case, is Messrs. Hancock and Atthey's "carpal bone," of which more anon.

at from the front, displays a well-marked lateral curvature or bend, which enables us to distinguish a convex and a concave side. It will also be observed that the lateral surface is more gibbous or rounded on the convex aspect of the spine, flatter on the opposite, so that for purposes of description we may distinguish the two sides as "gibbous" and "subgibbous" respectively. Still regarding it from the front, it will be seen that the sculptured surface ends proximally in an acute angle; but the apparent middle line on which the tuberculated or "gyrating" ridges meet *does not bisect* this angle, but divides it so that the sculptured part is larger on the gibbous side. Now, turning the spine over so as to look at it from behind, we observe that the longitudinal cleft or sulcus leading into the central cavity is not in the middle of the non-sculptured inserted part, but is placed more towards the subgibbous side, so that we have here from the very beginning a marked deviation from bilateral symmetry, one side, the convex or gibbous one, being larger than the other. We next observe that, from the distal closure of the sulcus, the lip on its subgibbous side is continued onwards towards the apex as a blunt keel or margin, having on the gibbous side a shallow longitudinal depression or groove. Thus the spine has now become keeled or marginated posteriorly, and from this margin round to the line of convergence of the gyrating ridges in front the surface on the subgibbous side is narrower and flatter, while on the opposite or gibbous aspect it is more extensive, more rounded, and provided with the aforesaid longitudinal groove. I have already, on a previous occasion*, pointed out that the groove is obviously equivalent to the posterior flattened area in such median spines as *Ctenacanthus*, but here turned *awry* and looking to one side, while the posterior marginal ridge represents one of the denticulated margins in the last-named genus; the other is to be looked for in the opposite or feebly-marked edge of the groove on the gibbous side in *Gyracanthus*. The sculptured or gyrating ridges are on the whole pretty straight and parallel in their course, though they show a slight tendency to a sigmoidal direction, curving a little towards the apex in front, towards the base behind, as well as increasing progressively in obliquity from the base onwards. They are closely tuberculated along their whole extent, and are continued as lines of tubercles over the lips of the posterior groove, in the bottom of which they converge and meet. In the above described specimen the groove is filled with tubercles as far as the spine reaches; but in others the groove becomes bare of tubercles at a variable distance

* Geol. Mag. dec. ii. vol. ix. (1882), p. 542.

from the closure of the sulcus, and only marked by delicate longitudinal striæ, while in one I find it devoid of tubercles along its whole extent. In some too, before the truncation of the apex occurs, the gyrating ridges tend to lose their close tuberculation, at least posteriorly, and to become only distantly nodulose or even quite plain.

Putting the wearing of the tips altogether aside as a secondary question, the striking want of bilateral symmetry in these spines, together with their occurrence in "rights and lefts," amply justifies the opinion of Messrs. Kirkby, Atthey, and Hancock that they were pectoral or at least paired appendages. Which are the right and which the left spines it is, however, at present not very easy to determine. Accepting the sulcated aspect as posterior, it would be necessary to ascertain whether the flat or the gibbous side was superior in order to indicate to which side of the fish it belonged.

Now, turning to the spines labelled "dorsal" in the same collection, we find that they are smaller in size, varying in length from 4½ to 10½ inches, and almost all lying laterally compressed on pieces of shale. In this way the lateral curvature is obscured, though in one, also marked "dorsal," which happens to be only obliquely placed on its matrix, this curvature is quite obvious. Furthermore, all of them show in other respects the same want of lateral symmetry which I have just described in those acknowledged to be pectoral, namely the possession of a flat and of an inflated and grooved side; in fact they are rendered still more asymmetrical than the large truncated spines by the much greater prominence and sharpness of the posterior marginal keel, which we have seen is morphologically a lateral structure in the general plan of the spines. This keel is also furnished with a row of small closely-set recurved denticles. The gyrating ridges become very oblique towards the point, and tend to become plain or only distantly nodulose, except perhaps on the front of the spine. On the flat side a space bare of ridges runs down from the point along the posterior margin for about 1½ inch, and an analogous appearance is also observable on the grooved side. The groove itself is smooth and marked with delicate longitudinal striæ; and, as Messrs. Hancock and Atthey have already noted, the point is much compressed laterally*.

If we next compare the proximal or basal end of one of the

* These young spines of *G. tuberculatus* bear an extreme resemblance to the figure of *G. denticulatus*, Davis, in Ann. & Mag. Nat. Hist. (5) vi. 1880, p. 373, being similar in shape, in the characters of the gyrating ridges, and the denticulation of the posterior margin, while the same bare space runs down for a little distance from the point. Mr. Davis, however, states that his spine has *two* rows of denticles posteriorly.

largest of these supposed dorsal spines with the distal extremity of one of the least worn of those labelled "pectoral," we find a mutual approximation in character; and, further, if we compare both with an allied species, *G. nobilis*, Traq., from the Edinburgh district, pretty large specimens of which sometimes occur with the points very slightly worn indeed, the whole matter is cleared up. I have now no longer any doubt that the spines of *Gyracanthus tuberculatus*, supposed by Messrs. Hancock and Atthey to be "dorsal," are simply young specimens of the very same spines classed by them as "pectoral," and represent the distal portions or extremities, which in the adult spines have been lost by attrition. These spines increased by progressive growth at the base, and as they grew, progressive differences in sculpture, amount of lateral compression, and so on manifested themselves; so that the young spine is not a miniature of the old one, but represents only a distally situated portion of it, greater or less as the case may be. And in the case of the Newsham specimens of *Gyracanthus tuberculatus*, I may mention, as a final and convincing proof, that, although Messrs. Hancock and Atthey state that in the spines supposed by them to be dorsal the pointed extremities "are all perfect, not being in the least worn," I find in one so labelled, a specimen 11 inches in length, very distinct wearing already in progress just in front of the tip.

Although Messrs. Hancock and Atthey's dorsal spines of *Gyracanthus* are certainly not so, and although, since my attention was directed to the subject, I have not been able to find in any collection, public or private, spines of this genus to which I could assign a median position, and am consequently inclined to doubt the presence of dorsal spines altogether, I do not mean to affirm that the subject is thereby closed. Further investigation is necessary into the Irish Lower Carboniferous *G. obliquus* of M'Coy*, and into two American species named *G. compressus* † and *G. Alleni* ‡ by Prof. Newberry, the published figures of which do not indicate a want of lateral symmetry. M'Coy gives an outline of the transverse section of *G. obliquus* from a position considerably proximal to the point, in which the two sides with the posterior area seem as symmetrical as in a *Ctenacanthus*. In such a spine it would be well to examine the extreme point. There is in the collection of the Geological Survey of Scotland a rather young spine from the Liddesdale beds, which I am

* Palæozoic Fossils, p. 629, pl. iii. *k*, figs. 13, 14.
† Pal. Ohio, vol. i. p. 330, pl. xxxvii. figs. 1, 2.
‡ *Ib.* p. 331, pl. xxxvii. fig. 3.

inclined to refer to *G. obliquus*, and in it, near the tip, the transverse section has a form much resembling in general characters that in M'Coy's figure; but one margin of the groove is nevertheless a little more prominent than the other. It is to be hoped that American palæichthyologists will carefully examine the spines of *Gyracanthus* occurring in their country with special reference to the present question.

2. *The supposed Carpal Bones of* Gyracanthus.

Of constant occurrence in the same beds with *Gyracanthus* spines, and often found closely associated with them on the same slabs of stone, are certain peculiar bones, first noticed by Messrs. Hancock and Atthey, and by them interpreted as "carpal" bones. These occur of two forms or shapes, the first of which was described by the above-named authors in 1868*. It is a flat triangular bone, with a thick apex opposite to a thin base; and two other sides, one of which, the longer, is slightly convex, the other, or shorter, being straight or slightly concave: of the two surfaces one is slightly convex, the other slightly concave in general contour. Of these Messrs. Hancock and Atthey say, "Their structure is very open; and as they are seldom well preserved, they are probably only imperfectly ossified; the bony fibre radiates from the apex to the expanded base. There can be little doubt that these are carpal bones similar to those in connexion with the pectoral fins in sharks and dog-fishes."

The second form is briefly noticed by the same authors in another communication published four years later, and its form is described as follows:—"This second form is probably the inner carpal; it is a broad flat bone irregularly bilobed or somewhat reniform, with one of the lobes produced and the external margin straightened; the convex border is a little flattened, angulated, and thickened, thence the bony fibres radiate to the opposite or lobed margin. . . . The texture of the bone is quite similar to that of the large triangular carpal, namely, it is of a semicartilaginous appearance, with coarse radiating fibres extending from margin to margin"†.

In other passages Messrs. Hancock and Atthey clearly indicate that they considered the thin margin, in both forms, to be distal, and the apex, or point from which the "bony fibres" radiate, to be proximal in original position.

Before making any critical remarks on the above determination of the bones in question, it is necessary to fix accu-

* Ann. & Mag. Nat. Hist. ser. 4, 1868, vol. i. p. 369.

† Ann. & Mag. Nat. Hist. ser. 4, 1872, vol. ix. pp. 260, 261.

rately to what elements of the Selachian skeleton Messrs. Hancock and Atthey compare them.

The term "carpal" is not used by anatomists of the modern school to denote any part of the skeleton of the fore limb in fishes; but on turning to Prof. Owen's 'Comparative Anatomy of the Vertebrata,' vol. i. p. 168, fig. 104, we find the three basal cartilages of the pectoral fin of the picked dogfish so designated. Two of these, the *mesopterygium* and *metapterygium* of Gegenbaur, are triangular, with their apices directed towards the shoulder-girdle, while the third or *propterygium* has an oblong shape, faintly reminding us of the second form of so-called carpal of *Gyracanthus.* There can thus be no doubt that these basal cartilages, which, in the skeleton of the recent shark, intervene between the shoulder-girdle and the radial cartilages, or cartilaginous fin-rays, are the elements which Messrs. Hancock and Atthey meant by the term carpal. And the question is simply this, Is it likely that the process of calcification in such cartilages would give rise to bodies like the peculiar bones so often found associated with the spines of *Gyracanthus*? Or can any better explanation of their nature be suggested?

One point in their external configuration was not noticed by Messrs. Hancock and Atthey, namely, that these bodies were hollow, and that their extreme flatness is due to the crushing together of the thin walls of the internal cavity. If we take first one of the triangular series, it may easily be seen that the two walls, or laminæ of which the bone is composed, are united at the apex and along the two thick sides which meet at the apex, but that they are separate at the thin base, at which accordingly the cavity was open. It may also be seen that the edges of the basal opening do not coincide, as careful development of these edges shows that the one on the convex side of the bone is indented by a large angular notch or sinus, which runs up for some distance in the direction of the apex; this appearance I have seen in every case in which I have looked for it. The internal cavity is at once distinguishable, filled with matrix, when a specimen is broken or cut across. I have equally assured myself of the hollow character of the bones of the second series.

If we now look at the texture of these bodies we shall be at a loss to explain the expressions "imperfectly ossified" and "semicartilaginous," used by Messrs. Hancock and Atthey, in the passages already quoted. On examining the surface with a lens its apparent fibrous aspect is seen to be due to its being closely covered with minute grooves interspersed with small openings, these markings being clearly vascular in their nature and of the same essential character as those on the inserted portion of a Selachian spine, only not so regularly parallel as is usually the case in the latter. On making microscopic sections, transverse and longitudinal, through the substance of the supposed "carpal bone," it is found to be completely traversed by a close network of vascular or Haversian canals, the canals in some parts enlarging so as to give a rather more open character to the tissue than is found in the internal part of a *Gyracanthus*-spine itself, while the ground-substance, hard and calcareous, is permeated by minute branching and anastomosing tubules, which are frequently seen to radiate from the vascular canals. This is not, however, the structure which Selachian cartilage assumes when calcified or "ossified"*; on the contrary, if the tissue be not vascular dentine, it is certainly very like it.

I am therefore of opinion, that the bodies in question have nothing to do with "carpal bones," or with the endoskeleton of a shark at all, but that they were, on the other hand, dermal appendages, which may probably enough have been situated in the neighbourhood of the pectoral fin, the thin or open side being proximal and the apex distal. The want of enamel, or of sculpture on any part of the surface, shows that they must have been covered with a thin layer of skin. Their frequent occurrence in close relation to the spines of *Gyracanthus* renders it, indeed, highly probable that they belong to the same fish.

I hope, on a future occasion, to enter more minutely into the microscopic structure, both of these bodies, and of the *Gyracanthus*-spines themselves.

3. *On two new Species of* Gyracanthus.

In the 'Geological Magazine' for last month (Nov. 1883) I have given brief diagnoses of two new species of this genus from the Carboniferous Limestone series of Scotland, concerning which I propose, in the present communication, to enter a little more into detail.

Gyracanthus nobilis, Traquair.

Gyracanthus tuberculatus, Traq. Geol. Mag. dec. ii. vol. viii. 1881, p. 34.
Gyracanthus nobilis, Traq. ibid. dec. ii. vol. x. 1883, p. 542.

The spines which I have named *Gyracanthus nobilis* are of

* For an account of the structure of calcified Selachian cartilage, see Williamson on the "Structure and Development of the Scales and Bones of Fishes," Phil. Trans. 1851.

common occurrence in the ironstone worked at Borough Lee, near Edinburgh, belonging to the Middle Carboniferous Limestone series of Central Scotland; and I have also seen a fragment from a similar horizon at Cowdenbeath, in Fifeshire. At first I confounded them with *G. tuberculatus*, Ag., but the accession of more extensive material, along with a closer investigation of the subject, soon convinced me of their specific distinctness.

Gyracanthus nobilis attains a large size. One spine in my own collection, wanting a small portion of the base, but having its extreme point preserved, measures 21 inches; had it been entire its length could not have been less than 2 feet. Another, wanting the point, must have been about the same size; and fragments are not uncommon which indicate still greater dimensions. The general form is elongated and slender, the breadth increasing more rapidly towards the base in adult specimens. They are very variable in respect of curvature: in some both antero-posterior and lateral curves are well marked; in others the lateral bend is only slight or hardly perceptible; and I have one which appears almost perfectly straight in both directions. Every one of them, without exception, is nevertheless asymmetrical as regards those special points of configuration upon which I have dwelt in connexion with *G. tuberculatus*, and, as in that species, they may be arranged in pairs.

In the form of the non-sculptured inserted part, with its posterior sulcus, and in the general configuration of the spine as seen in transverse sections, *G. nobilis* closely resembles *G. tuberculatus*. The posterior marginal keel is in its distal portion strongly denticulated; in one specimen the denticles may be traced, from the point, a distance of 10 inches in the direction of the base. The posterior groove varies much in its degree of sharpness; in some it is very shallow and slightly marked till towards the point, while in others it is very well defined along its whole extent. In adult specimens continuations of the gyrating ridges usually encroach upon it at its commencement; but the salient point in this species lies in the disposition and mode of tuberculation of these ridges. At the proximal end of the spine, in adult examples, they are disposed much as in *G. tuberculatus*, meet each other anteriorly at much the same angle, and are closely tuberculated along their whole extent. But near the closure of the sulcus this close tuberculation becomes limited to the anterior aspect, each ridge as it arises and advances forward showing first a comparatively distant tuberculation, then a smooth space (sometimes very minutely crenulated) on the side of the spine, and finally becoming thick and coarsely tuberculated as it turns round to the front. Where this feature of the ridges commences *they also become excessively oblique and very delicate*, and in some specimens they also occasionally bifurcate along the sides of the spine; but in front, where the tuberculation appears, *they become coarse and curve a little forward*, so as to become less oblique, and in many cases they turn slightly again towards the point just before meeting those of the opposite side. Towards the extremity the ridges become entirely smooth on the sides of the spine, their slight curvature also ceases, and the tuberculation of the anterior aspect gives way to simple undulation. The point, even where it is not positively truncated by attrition, looks smooth and rubbed.

Gyracanthus nobilis may easily be distinguished from both *G. formosus* and *G. tuberculatus* (probably only varieties of one common species) by the direction of the gyrating ridges. In the latter forms these ridges are disposed in a pretty straight and parallel fashion over the sides of the spine, although they do increase in obliquity towards the apex. Here, however, their excessive obliquity and delicacy along the sides, after the closure of the sulcus, give the sculpture a peculiar aspect which cannot be mistaken. The tuberculation of the ridges is in general coarser than in *G. tuberculatus*, and, in the latter, it is only pretty well towards the apex that the ridges tend proximately to become plain, or only distantly nodulose. Of course, as regards the disposition of tuberculation, this new species differs still more from *G. formosus*, in which the ridges, from the very base, tend to be plain in front.

Adult specimens of *G. tuberculatus* show invariably, so far as I have observed, a strongly-marked lateral curvature; in *G. nobilis*, as we have seen, its presence and amount is very variable.

The course of the ridges, the disposition of the tuberculation, and the form of the transverse section equally distinguish it from *G. obliquus* of M'Coy, and it is certainly not *G. denticulatus* of Davis. Nor can it be shown to be identifiable with any of the North-American species named by Prof. Newberry and Dr. Dawson.

There only remains the *G. alnwicensis* of Agassiz, which is recorded from a somewhat similar horizon, viz. the Carboniferous Limestone series of Alnwick, in Northumberland. This is very briefly mentioned by Agassiz as being slender in form, with very oblique and entirely smooth or non-tuberculated ridges, which ridges also bifurcate, and even trifurcate, in a very remarkable manner, as shown in the figure. If this description is correct *, *G. nobilis* is even more distinct from *G. alnwicensis* than from any other.

One remarkable feature in these spines as occurring at Borough Lee is the small amount of apical wearing to which they have for the most part been subjected. Even the extreme point, only a little blunted and polished, is sometimes present in large specimens, and in many others comparatively little of the extremity has been lost by that process which has reduced some of the large *Gyracanthus*-spines from Northumberland and Staffordshire to mere stumps. It has been noted that this wearing process has obliquely truncated the Northumbrian specimens in their anterior aspect; but in those from Borough Lee evidence of wearing is sometimes found on the posterior aspect as well. These circumstances would lead us to infer some difference either in the habitat or the habits of the species in question.

Gyracanthus Youngii, Traq.

Gyracanthus Youngii, Traq. Geol. Mag. dec. ii. vol. x. 1883, p. 543.

Occurring also at Borough Lee, but found likewise in many other localities on the horizon of the Scottish "Edge" Coal or Middle Carboniferous Limestone series, is a remarkably distinct species of *Gyracanthus*, to which I have given the name *C. Youngii*, in honour of my friend Mr. John Young, of the Hunterian Museum, Glasgow, who has done so much for the elucidation of the palæontology of the west of Scotland. The finest specimens I have seen are in the collection of Mr. R. Craig, Beith, Ayrshire, and are from the shale overlying the Clay-band Ironstone at Barkip, Dalry. I have also seen specimens from Bo'ness in Linlithgowshire (collection of Mr. H. M. Cadell), Possil in Lanarkshire (collection of Mr. John Young), Cowdenbeath in Fife, and Maryhill near Glasgow.

These are large spines, some of which must have attained a length of over 2 feet, had not their apices been worn off. They always show some amount of lateral curvature; but the degree to which they are antero-posteriorly bent is very

* Possibly it is not, as Agassiz never saw the specimen, but drew up his description from a drawing sent to him by Messrs. Buckland and De la Beche. As reproduced in the plate in the 'Poissons fossiles,' this drawing looks like a very hurriedly executed pen-and-ink sketch, from which it is quite impossible to identify any thing. Under these circumstances doubt whether the term "*alnwicensis*" has any more value than a mere manuscript name.

variable; some are indeed in that direction nearly quite straight.

The first salient point which strikes the eye is the great size of the inserted or non-sculptured portion, which is not only broader and more expanded, but extends further beyond the sculptured part proximally than in any other species. The anterior middle line on which the gyrating ridges meet does not cut equally the very acute angle formed proximally by the sculptured part; but in this case the larger division is found on the subgibbous side, this being due to the encroachment of the non-sculptured part on the gibbous side. It is next to be noticed that the shaft of the spine after the closure of the sulcus is more cylindrical than in other species; still the want of bilateral symmetry is very obvious, and a gibbous and subgibbous side may be distinguished. The posterior groove is sometimes not apparent for some distance after the closure of the sulcus, or, though indicated, it may be filled with tubercles; sooner or later it becomes well marked, and the lip on the subgibbous side becomes more prominent than the other, but does not form so marked a feature in the configuration of the spine as the corresponding posterior marginal keel in such species as *G. tuberculatus* and *nobilis*; it is in fact only towards the extremity, that the spine takes on a keeled appearance. A well-marked row of recurved denticles occurs along the aforesaid lip or ridge of the posterior groove on the subgibbous side, and on that of the opposite side denticles are also seen in some examples. The last remarkable feature in this species is the slight obliquity of the gyrating ridges, which meet each other on the front of the spine at angles greater than right angles almost as far as the very apex. These ridges are also rather less oblique on the subgibbous than on the gibbous side; on the former they are in fact sometimes nearly transverse; a certain amount of sigmoidal curvature is assumed after the middle of the spine, the anterior extremities of the ridge turning slightly towards the apex, their posterior extremities towards the base. Only towards the apex have the ridges any marked obliquity in their middle portions, and there they often also become wavy. The gyrating ridges are closely tuberculated over their whole extent, except towards the apex, where the tuberculation tends to become irregular. The amount of apical wearing is very variable.

V.—*Report on the Polyzoa of the Queen Charlotte Islands.* By the Rev. THOMAS HINCKS, B.A., F.R.S.

[Continued from vol. xi. p. 451.]

[Plates III. & IV.]

LEPRALIA (part.), Johnston.

Lepralia bilabiata, n. sp. (Pl. III. fig. 1.)

Zoœcia quincuncially arranged, short, very slightly convex, the sutures little more than incised lines, rounded above (where the cell-wall forms a distinct border round the orifice), widening out at each side, and narrowing off towards the base, which is subtruncate or pointed; surface dense, smooth, of a somewhat waxy appearance and a dark brown colour; orifice large, occupying nearly half of the front surface, rounded above, slightly contracted a short distance above the lower margin, which is arched outwards; peristome unarmed, not elevated; operculum smooth, of a deep black colour, with a slight rim round the edge, the inner surface attached to a bilabiate tubular passage (Pl. III. fig. 1 *b*), through which the polypide issues. *Avicularia* none. *Oœcium* a subtriangular extension of the cell above the orifice, very little raised, a great part of its front surface occupied by a large foramen, closed in by membrano-chitinous material (Pl. III. fig. 1 *a*).

Zoarium of a very dark brown colour (almost black).

Houston-Stewart Channel, on shells.

When the zoœcium is open, the orifice is occupied in great part by the entrance to a tubular passage, through which the polypide issues; this entrance is bilabiate, the lower lip consisting of a semicircular chitinous rim, as it were soldered to the inner surface of the operculum; the upper or opposed lip, also chitinous, is movable, and closes upon the opercular lip when the polypide retreats.

The structure of the ovicell in this species is peculiar; it consists of a short extension of the cell upwards, the front wall of which is much depressed, and bears a large foramen, with a chitinous lid or covering. The oœcial chamber is small, and the entrance to it is closed by the operculum of the cell. This is a very distinct modification of the ordinary form of oœcium.

L. bilabiata is luxuriant in growth, and forms very large spreading crusts.

Lepralia claviculata, n. sp. (Pl. III. fig. 2.)

Zoœcia ovate or lozenge-shaped (sometimes irregular in shape and size), regularly quincuncial, depressed; surface glossy, thickly covered with minute circular punctures, which give it a pretty speckled appearance; orifice arched and expanded above, more or less narrowed downwards, contracted by a small acute projection on each side just above the lower margin, which is distinctly curved; peristome not raised. *Avicularia* keyhole-shaped, placed on a distinct area, very much smaller than that of the cell, sometimes immediately above a zoœcium, more commonly in the angle between two zoœcia; mandible directed upwards. *Oœcium* (fig. 2 *a*) very large, higher than broad, depressed towards the opening, and often grooved longitudinally above the oral arch, rising above into a kind of central knob (but on the whole not much elevated), white, glossy, thickly punctured.

Zoarium forming large, spreading, whitish crusts.

Houston-Stewart Channel; Cumshewa, 20 fms.

Cases occur in which the avicularium is situated on an area almost as large as that of the cells, just below the upper extremity, occupying, in fact, the position of the oral aperture. Occasionally two of these appendages occur together, either placed one above the other or side by side.

PORELLA, Gray.

Porella concinna, Busk.

Cumshewa, on shell.

[Britain, Adriatic, Finmark, Norway, Spitzbergen, Franz-Josef Land (*Ridley*), Greenland, Gulf of St. Lawrence, Bass's Straits.]

A beautiful variety occurs in which the whole surface of the cell, except the umbo below the orifice, is covered with rather large punctures; the orifice is ample, and its characteristic features are very distinctly marked. The zoarium is white, and delicate in texture.

Porella marsupium, MacGillivray, form *porifera*. (Pl. IV. fig. 4.)

This species, which is a common Australian form, occurs abundantly amongst the dredgings. The specimens from the Queen Charlotte Islands differ from those which I have examined from Bass's Straits in one or two points, but they are quite unimportant. On the front of the suboral swelling, which supports the avicularium, are two (or occasionally three) rather large circular pores, placed side by side. They give a somewhat peculiar appearance to the cell, but do not seem to have any special significance. Frequently too there is a small raised oval avicularium on the front of the cell, besides the oral avicularium, which I have not noticed on Australian specimens. The cell-wall is smooth and entire; the oœcium is traversed by delicate radiating lines.

Extremely common, on shells &c.

[Victoria (*MacGillivray*); Bass's Straits (*Capt. Cawne Warren*).]

The species described by Mr. Ridley from the Straits of Magellan (Proc. Zool. Soc. Jan. 4, 1881) as *Schizoporella marsupium*, and identified by him with MacGillivray's *Lepralia marsupium*, is, I have no doubt, the *Escharina simplex* of D'Orbigny ('Voyage dans l'Amérique Mérid.'), obtained from "les Iles Malouines." MacGillivray, who has found this species in Victoria, has named it *Schizoporella Ridleyi* (Proc. Roy. Soc. Victoria, Oct. 12, 1882).

We have no alternative, however, but to revert to the earlier designation, and it must stand as *Schizoporella simplex*, D'Orb.

Porella major, n. sp. (Pl. IV. fig. 5.)

Zoœcia ovate or (sometimes) hexagonal, somewhat elongate, quincuncial, rather depressed, sutures shallow, often with a line of punctures round the margin; surface smooth or slightly roughened, glossy; orifice arched above, lower margin curved inwards, so as almost to appear dentate; peristome thin, unarmed, elevated (in the adult cell), especially above, immediately below the orifice a narrow avicularian swelling, stretching across the front of the cell and bearing in the centre a small oval *avicularium*, mandible directed downwards. *Oœcium* rounded, moderately prominent, surface minutely roughened, the peristome forming a raised rim round the oral arch.

Zoarium of a very light brownish colour.

Cumshewa; Houston-Stewart Channel, common on shells.

SMITTIA, Hincks.

Smittia trispinosa, Johnston.

Houston-Stewart Channel; off Cumshewa; Virago Sound: abundant.

[Britain, Norway, Arctic regions, St. Lawrence, Mingan Islands, Florida, Mazatlan, Cape Horn, Aden, Adriatic, East Indies (*Dr. Anderson*), Bass's Straits.]

Several varieties occur. As a rule, the avicularian appendages are present in great profusion and of unusual size.

Smittia plicata, Smitt.

Houston-Stewart Channel; off Cumshewa, 20 fms.: not uncommon.

[Spitzbergen, Greenland, 100 fms., Godhavn Harbour, Disco.]

The form which I refer to Smitt's *Cellepora plicata* differs slightly from the description and figures given by that author; but in essential particulars, I believe, it agrees with them. In the specimens from the Queen Charlotte Islands the avicularium is well within the peristome, and there is little if any trace of the umbo, on which, according to Smitt, it is placed in his *C. plicata*. This, however, may be due to the greater development of the peristome, by which the umbo may have been to a large extent concealed. The cells are often invested by a membranous epitheca.

Smittia spathulifera, n. sp. (Pl. IV. fig. 3.)

Zoœcia large, ovate, quincuncially arranged, very moderately convex, bordered by delicate raised lines; surface covered with rather large round punctures, which, however, are in great measure concealed by the stout epitheca that clothes the zoarium; orifice arched above, lower margin straight and within it a large bifid tooth; peristome much raised (especially above) forming an elongate secondary orifice, produced below into a spout-like sinus, which is occupied by a spatulate *avicularium*; mandible directed downwards. *Oœcium* large, immersed, closely united to the cell above; surface roughened, punctured round the edge. *Zoarium* forming a brownish crust.

Houston-Stewart Channel.

MUCRONELLA, Hincks.

Mucronella ventricosa, Hassall.

Virago Sound, in about 20 fms., on shells.

[Britain, France (S.W.), Mediterranean, New Zealand, Bergen, Greenland, Nova Zembla, Kara Sea.]

Mucronella pavonella, Alder.

Virago Sound.

[St. Lawrence, Greenland, Nova Zembla, Spitzbergen, Finmark, off Jutland, Britain (north-east).]

Mucronella prælucida, n. sp. (Pl. IV. fig. 1.)

Zœocia large, ovate, quincuncial, slightly convex, separated by raised lines; surface thickly covered with roundish punctures, lustrous; orifice arched above, lower margin straight (without denticles), peristome raised, especially at the back and in front, where it rises in the centre into a blunt mucronate projection, which bends slightly inwards; the surface of the peristome smooth, entire, and very glossy. *Avicularia* none. *Oœcium* (?).

Houston-Stewart Channel, not uncommon on shells.

Mucronella prælonga, n. sp. (Pl. IV. fig. 2.)

Zoœcia long and (usually) slender, quincuncially disposed, somewhat wider above than at the base (elongate-ovate, sometimes appearing almost subtubular), convex, depressed below, rising towards the oral extremity; surface thickly covered with minute punctures, shining (the glistening appearance due to the presence of an epitheca); orifice suborbicular, peristome elevated round it, carried out in front into a very prominent process, often much thrown back and greatly elongated, sometimes simply pointed, sometimes bi- or trimucronate, on the inner side of it near the base a single, small, sharply-pointed denticle; the upper margin produced in the centre into a tall spinous process, broad at the base, attenuated and membrano-calcareous above. *Avicularia* none. *Oœcium* (?). *Zoarium* forming a whitish subcircular crust.

Houston-Stewart Channel, on shell.

A very picturesque form, distinguished by the remarkable processes on the upper and inferior margins of the peristome. The mucro in front is sometimes very greatly elongated, and, in such cases, the upper portion seems to be formed of very delicate membrano-calcareous material. The spinous extension of the peristome on the upper margin, which is much attenuated above, is also made up, to a great extent, of similar material. The subtubular character of the zoœcia is a striking feature, though occasionally, and especially near the growing edge of the colony, they assume a more distinctly ovate form.

Mucronella spinosissima, Hincks, form *major*.
(Pl. III. fig. 3.)

Zoœcia broad-ovate, short, arranged in quincunx, very convex, sutures deep, surface smooth, subhyaline in the younger cells, opake in the older, a number of slender tubules immersed in the cell-wall immediately beneath the surface, and radiating from the margin towards the centre, the aperture opening out apparently on the surface, but closed by a calcareous diaphragm; the oral extremity of the cell much raised, contracted, suberect, forming a neck which bears the orifice; orifice suborbicular, a small mucronate projection in the centre of the lower margin, the rest of the peristome occupied by 6–10 tubular spinous processes, a denticle within the peristome on the lower primary margin. *Avicularia* none. *Oœcium* (fig. 3 *b*) rounded, developed behind the neck-like peristome (the orifice, with its full armature of spines, rising before it), sometimes traversed by a number of the immersed tubules. *Primary cell* (fig. 3 *a*) small, ovate; aperture occupying about two thirds of the front surface, surrounded by a raised border, which bears about 8–10 spines; the orifice nearly semicircular, occupying the upper portion of the aperture, the lower part closed in by a delicate membrano-calcareous covering; portion of the cell below the aperture smooth and solid.

Zoarium forming very large cream-coloured crusts on shells.

Extremely abundant; probably the commonest species amongst Dr. Dawson's dredgings.

[Bass's Straits (*Capt. Cawne Warren*).]

I have ranked this interesting form as a variety of *M. spinosissima*, a species which I have described and figured in my report on the Polyzoa of Bass's Straits ('Annals' for Aug. 1881). In all the principal elements of structure there is an exact correspondence between the two; but there are also one or two differences, which materially affect the general appearance, and, at the first glance, few probably would be likely to identify them. In the present variety the cells are very much larger than those of the Australian form. The latter are small and delicate, while those of the variety *major* are ample, broadly ovate, massive, and strongly built. But the chief difference between them lies in the system of tubules, more or less immersed in the cell-wall and showing as white striæ on the glossy surface, which gives so distinctive a character to the North-Pacific form. Of this tubular structure I have been unable to detect any trace in the Australian specimens which I have examined. Possibly the condition of the stony crust may be such as to conceal it; but this hardly seems probable, as in the finest colony which has come under my notice calcification has evidently not proceeded far. It may also be noted that the cells of the Australian variety have a well-marked row of punctures round the margin.

At present, looking to the close structural agreement between the two forms, and in the absence of any precise knowledge as to the development and function of the tubules, I prefer to include them in one specific group.

The tubules appear as delicate white lines through the subhyaline crust, radiating from the circumference towards the centre of the zoœcium. They vary much in length, some being almost rudimentary, and others extending nearly or quite to the centre of the cell. Not unfrequently short tubes alternate with the longer ones; and commonly the latter seem to be composed of several short tubules, which originate one from the other, a little below and behind the orifice. In the younger zoœcia the tubules are, I believe, *on the surface*; but they are soon overgrown by the calcareous crust, and in older states they are completely concealed by it. In highly calcified colonies this feature disappears, and the cells present a uniform opake surface. The tubules traverse the neck-like portion of the cell, and the numerous oral spines seem to be nothing more or less than their free extremities projecting beyond the margin of the peristome.

It is difficult to form a conjecture as to the precise import of the tubular system, and the more so as there has been no opportunity thus far of tracing the growth of the cell-wall and the mode in which the tubules originate.

The primary cell of *Mucronella spinosissima* closely resembles that of *M. Peachii*.

Retepora, Imperato.

Retepora Wallichiana, Hincks.

Houston-Stewart Channel, 15–20 fms.

[Spitzbergen, 20–80 fms., Finmark, Godhaab, 150 fms.]

This form was first described by Smitt * as a variety of *R. notopachys*, Busk, a Crag fossil. Some years later the examination of specimens obtained by Dr. Wallich in Davis Straits convinced me that it was a distinct species, and it was accordingly described as such ('Annals' for Jan. 1877, p. 107), with the name which Mr. Busk had already assigned to it in MS.

R. Wallichiana, when fully developed, forms intricate convoluted and chambered masses of considerable size. It is one of the many arctic species which have migrated to the Queen Charlotte Islands.

Family **Celleporidæ.**

Cellepora (part.), Fabricius.

Cellepora incrassata, Lamarck.

Houston-Stewart Channel; Virago Sound, incrusting the stems of Hydrozoa.

* "Kritisk förteckn. öfver Skandinavien's Hafs-Bryozoer," Œfvers. Kongl. Vetensk. Akad. Förhandl. 1867, Bihang.

[Finmark, Spitzbergen, Greenland, Banks of Newfoundland.]

Cellepora, ? sp.

Zoarium incrusting, of a rather dark brown colour. *Zoœcia* (towards the centre of the colony) erect, crowded, barrel-shaped, some elevated, some immersed; surface smooth, more or less punctured round the margin; orifice arched above, lower margin slightly curved outwards (suborbicular), and having in the centre a small notch, rounded below and contracted at the opening by two minute denticular projections; operculum arched above, straight and entire below; peristome raised in front, embracing a short and stout rostrum, placed immediately below the oral notch, and bearing an *avicularium* on one side close to the top, with rounded mandible directed upwards; two very tall articulated marginal spines, placed one on each side of the orifice above. Large *avicularia* scattered amongst the cells with a broad subspatulate mandible, the beak elevated at the extremity into a hood-like projection, not denticulate. *Oœcium* (?).

Incrusting Retepora and shells.

I cannot identify this form with any of the described species known to me; but I am by no means prepared at present to say that it is new to science. It does not appear (so far as I can judge in the absence of the figures) to be included amongst the 'Challenger' *Celleporæ* characterized by Busk (Journ. Linn. Soc. vol. xv. 1881, p. 341, &c.). If it should prove to be (as I suspect) undescribed, I should propose for it the name of *Cellepora brunnea*.

Additional.

Family **Porinidæ**.

Lagenipora, Hincks.

This genus, as originally constituted *, was formed for a Porinidan species in which the cells are more or less immersed in a calcareous crust. But I am now convinced that this character cannot properly be made the foundation of a generic group, and I propose to apply the name to such forms as possess a lageniform cell with a free orbicular orifice and are destitute of a special pore. The original type of the genus, *L. socialis* mihi, will hold a place in the reconstituted group,

* 'Annals' for September 1877; 'Hist. Brit. Marine Polyzoa,' vol. i. p. 235.

along with *Phylactella lucida* mihi, a Madeiran species (see 'Annals' for July 1880), and a kindred form from the Queen Charlotte Islands, which I shall now describe.

Lagenipora spinulosa, n. sp. (Pl. III. fig. 4.)

Zoœcia lageniform, rather irregularly disposed, the lower portion adherent, ovate, thickly covered with punctures (sometimes almost obliterated, when the surface appears roughened or subgranulous); the oral extremity free, tubular, much produced, suberect, the surface perfectly smooth and subhyaline, slightly expanded upwards; orifice terminal, suborbicular, the front margin plain or trimucronate, and more or less elevated above the rest, somewhat everted, on each side a raised process bearing a small *avicularium* of the *Scrupocellaria* type, with minute pointed mandible directed outwards, on the upper (or hinder) margin several spinous processes. *Oœcium* small, rounded, smooth, placed far down at the back of the tubular portion of the cell.

Zoarium forming small lobate patches.

On *Tubulipora* (especially) and shells; not uncommon.

This form is nearly related to *L. lucida*, mihi, but is, I have no doubt, distinct. There is a marked difference between the avicularia of the two species. In *L. spinulosa* there are two, one on each side of the orifice, resembling very closely the form which is characteristic of the genus *Scrupocellaria*. In *L. lucida* there is only a single minute, oval avicularium, which is borne on a stout process, in the centre of the lower margin. *L. spinulosa* is altogether stouter in habit than the Madeiran species, and in the normal state the adherent portion of the cell is thickly punctured, whereas it is entire and smooth and subhyaline in the latter. It differs from *L. lucida* in another point. On each side of the free tubular portion of the cell there is a very distinct line, running the whole length of it, which seems to mark the junction between the front piece and the rest of the tube. The strongly marked groove at the base of the neck-like extension in *L. lucida* is wanting in the present form, which is also characterized by a peculiar habit of growth.

Microporella Malusii, Audouin.

A variety of this species occurs, in which there is a very prominent umbo below the pore.

Schizoporella biaperta, Michelin.

In a variety of this widely distributed species from the

Queen Charlotte Islands the lateral avicularia have a pointed mandible instead of the normal rounded one. Smitt has noticed the same thing in Floridan specimens.

EXPLANATION OF THE PLATES.

Plate III.

Fig. 1. *Lepralia bilabiata*, n. sp. 1 *a*. A zoœcium with ovicell. 1 *b*. Zoœcium with the operculum thrown back, showing the entrance to the tubular passage.
Fig. 2. *Lepralia claviculata*, n. sp. 2 *a*. Oœcium.
Fig. 3. *Mucronella spinosissima*, Hincks, form *major*; group of cells, showing the tubules in the front wall. 3 *a*. Primary cell. 3 *b*. Zoœcium, showing the position of the ovicell behind the tubular orifice.
Fig. 4. *Lagenipora spinulosa*, n. sp.

Plate IV.

Fig. 1. *Mucronella prælucida*, n. sp.
Fig. 2. *Mucronella prælonga*, n. sp.
Fig. 3. *Smittia spathulifera*, n. sp.
Fig. 4. *Porella marsupinm*, MacGillivray, form *porifera*.
Fig. 5. *Porella major*, n. sp.

VI.—*Lepidoptera from the Island of Nias*. By Arthur G. Butler, F.L.S., F.Z.S., &c.

The following species from the Island of Nias have recently been added to the collection of the British Museum :—

Euplœinæ.

Caduga funeralis, sp. n.

Nearly allied to *C. Banksii*, Moore (from Sumatra), but differing much as *Purantica eryx* does from *P. agleoides*, the wings being of a narrower and more elegant form, with the whole of the greenish-white markings much narrower; the abdomen a little browner. Expanse of wings 86 millim.

Salatura eurydice, sp. n.

Primaries above most like *S. nubila* of Gilolo, but the reddish area of the primaries of a lurid mahogany-red colour, more restricted, divided into three well-marked areoles by the median vein and its first branch, which are very broadly black-bordered, and bounded on costa and inner margin by broad black borders; the white spots on the black apical area also differ a little, the fifth in the subapical series being longer and wider, so that it becomes the largest of the series; below this series are two moderate-sized spots, as in *S. nubila*, and below the inner one (within the first median interspace) is a slightly larger spot; below the outer one and in the same interspace with it is a white dot, there are also four white submarginal dots, one at apex and three near the centre of outer margin; the secondaries are quite unlike those of *S. nubila* and allies, being of a smoky-brown colour, with white-spotted fringe, with nine white dots in a double series towards anal angle, and two placed obliquely near apex; these wings are therefore most like those of *S. ferruginea*. Expanse of wings 81 millim.

NYMPHALINÆ.

Doleschallia niasica, sp. n.

♀. Nearest to *D. pratipa*; primaries with the basal two fifths and inner border smoky fulvous, the apex and external border broadly black, and the intermediate area creamy white; a transverse black patch at the end of the cell, and three unequal decreasing white dots placed obliquely near apex; secondaries smoky fulvous, the costal area broadly smoky grey; two slightly undulated blackish submarginal stripes and the two usual black spots on the disk; abdominal border whitish towards the base; body dark olivaceous. Under surface with the pattern of *D. pratipa*, but the wings altogether paler than in any specimens known to me of that species. Expanse of wings 72 millim.

Symphædra perdix, sp. n.

♀. Allied to *S. æetes* of Menado, Celebes; blackish piceous, with white and tawny spots, arranged much as in *S. dirtea*, though differing in colour; the chief differences between the two females are as follows:—In *S. perdix* the two series of spots which cross the disk are considerably larger, those on the median interspaces being also confluent, so as to produce (with those which are confluent in *S. æetes* ♀ of Hewitson) a broad white angular belt, interrupted by black nervures, and throwing off three decreasing white spots from its angle to the costa; the submarginal spots are more regular, larger towards external angle, where they are whitish, but decreasing to a mere point towards apex; the two series of spots across the basal half of secondaries are larger and paler towards costa, the inner series terminating in a white subcostal spot; a second white subcostal spot is placed nearer to the base at the extremity of a fulvous stripe which borders the basal portion of the subcostal vein and its first branch; the tawny borders of the ocelloid discal series of spots are more isolated, the inner series less lunate; the body is black above, the antennæ tipped with fulvous, the thorax with two spots of ochreous behind the collar; two lateral white spots in the middle and two behind; the abdomen is spotted in front and narrowly banded behind with ochreous. The coloration and general pattern below are most like those of *S. dirtea* of Java, but differ in the decidedly more tawny ground-tint, excepting towards the abdominal border of secondaries (the area around which is, as usual, pale bluish), in the broad white belt on the disk of primaries, and the black edges of the discoidal and supradiscoidal spots of secondaries. Expanse of wings 102 millim.

This is one of the most handsome species in the genus; it approaches nearest to two females in Hewitson's collection regarded as my *S. canescens*, but decidedly larger than the type of that species; the latter, however, may vary, though certainly not sufficiently to include the Macassar female associated with it by Hewitson, and which is nothing more than the more prevalent variety of the insect described by Hewitson as the female of his *S. æetes* of Menado.

The true female of *S. æetes* is in Hewitson's collection from Tondano; and, excepting that it is larger, differs in no respect from the male. The female of the Macassar species, however, is larger still, and has the general character of markings of *S. dirtea*, excepting that the spots of the discal series, including the spots of the inner series of the furca, are larger, and thus form an angular band broken up into well-separated spots below the median vein, but only interrupted by the black nervures above it; the entire furca is occasionally composed of white spots, as in the type of Hewitson's description. The male differs chiefly from that sex of *S. æetes* in the larger white spots of the inner series of the furca on the primaries and in the narrow inner border of the ocelloid spots on the secondaries, so that there is no well-defined grey band across these wings as in *S. æetes.* I propose that this species should take the name of *S. phasiana*: so far as I know it occurs only at Macassar, the pair in our collection being taken in that locality, as well as one of Hewitson's females; a pair in his collection, however, is only labelled "Celebes," but was probably obtained from the same source as our examples.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.

November 21, 1883.—J. W. Hulke, Esq., F.R.S., President, in the Chair.

The following communications were read :—

1. "On the Skull and Dentition of a Triassic Mammal (*Tritylodon longævus*, Ow.) from South Africa." By Prof. Owen, C.B., F.R.S., F.G.S.

The specimen described in this paper formed part of a collection containing remains of some of the known South-African Triassic Reptilian genera, and agreed with them in its mode of fossilization. It was submitted to the author by Dr. Exton, of Bloemfontein. The specimen is a nearly entire skull, wanting only the hinder part, and it measures about $3\frac{3}{4}$ inches in length, from the broken end of the parietal crest to the point of the united premaxillaries. The upper surface shows the anchylosed calvarial portions of the parietals, and the frontal bones divided by a suture; the contiguous angles of these four bones are cut off, so as to leave an aperture, occupied by matrix, which may be a fontanelle, or a pineal or parietal foramen. The frontals form the upper borders of the orbits, which are bounded in front by the lacrymal and malar bones, and were not completed behind by bone. Each frontal is narrowed to a point at the suture between the nasal and maxillary. The nasals are narrow, but widen in front to form the upper border of the exterior nostril, which is terminal, and is completed by the premaxillaries. The maxillaries are widened posteriorly, then constricted, and again widened before their junction with the intermaxillaries.

The teeth include a pair of large round incisors, broken off close to the sockets, and showing a large pulp-cavity, surrounded by a complete ring of dentine, which is covered by a thin coat of enamel on the front and sides. At 2 millim. behind each of these teeth is the socket of a smaller premaxillary tooth; this tooth apparently had a thin wall and a pulp-cavity relatively larger than in the anterior tooth. It is separated by a ridged diastema from the series of six molar teeth on each side, the first of which has a subtriangular crown with the base applied to the second tooth. The latter and the four following teeth are nearly similar, subquadrate in form, with the crowns "impressed by a pair of antero-posterior grooves, dividing the grinding-surface into three similarly disposed ridges, and each ridge is subdivided by cross notches into tubercles. Of these there are, in the second to the fourth molar inclusive, four tubercles on the mid ridge, three on the inner ridge, and two on the outer ridge."

The author discussed the relations of this new form of mammal, especially as indicated by the structure of the teeth, which he showed to resemble those of *Microlestes*, from the Keuper of Würtemberg and the Rhætic of Somersetshire, and those of the Oolitic genus *Stereognathus*, the former having on each tooth two multituberculate ridges, and the latter three ridges, but with only two tubercles on each. The fossil presents no characters to show definitely whether the animal it represents was a placental or a nonplacental mammal.

2. "Cranial and Vertebral Characters of the Crocodilian Genus *Plesiosuchus*, Owen." By Prof. R. Owen, C.B., F.R.S., F.G.S.

In this paper the author, with the view of showing that the Kimmeridgian *Steneosaurus Manselii*, Hulke, really forms the type of a distinct genus, discussed the characters by which Cuvier divided the fossils referred by him to the Crocodiles into three principal groups, to which Geoffroy St.-Hilaire gave generic names, and those by which the latter author afterwards distinguished his genus *Steneosaurus*, including Oolitic forms, from the Liassic genus *Teleosaurus*. From his exposition of these characters the author concluded that the above-named species does not belong to *Steneosaurus*, Geoff., and he proposed to make it the type of a new genus, *Plesiosuchus*, characterized by the convergence of the frontal bones to a point nearer the apex of the skull than in *Steneosaurus*, by the extension of the gradually attenuated nasal bones into a point penetrating the hind border of the nostril, and by other peculiarities of the skull, teeth, and vertebræ. The author pointed out that this form, like *Steneosaurus*, helped to bridge over the space between the Liassic Teleosaurs and the Tertiary and recent Crocodiles, even approaching nearer to the latter than the older Oolitic type.

3. "On some Tracks of Terrestrial and Freshwater Animals." By Prof. T. McKenny Hughes, M.A., F.G.S.

The author's observations have been made on certain pits in the district about Cambridge which are filled with the fine mud produced in washing out the phosphatic nodules from the "Cambridge Greensand"—a seam at the base of the Chalk Marl. As the water gradually dries up, a surface of extremely fine calcareous mud is exposed. This deposit is often very finely laminated, and occasionally among the laminæ old surfaces can be discovered, which, after having been exposed for some time to the air, had been covered up by a fresh inflow of watery mud into the pit. The author described the character of the cracks made in the process of drying, and the results produced when these were filled up. He also described the tracks made by various insects, indicating how these were modified by the degree of softness of the mud, and pointed out the differences in the tracks produced by insects with legs and elytra, and by Annelids, such as earthworms. The marks made by various worms and larvæ which burrow in the mud were also described.

Marks resembling those called *Nereites* and *Myrianites* are produced by a variety of animals. The groups of ice-spicules which are formed during a frosty night also leave their impress on the mud. The author concluded by expressing the opinion that *Cruziana*, *Nereites*, *Crossopodia*, and *Palæochorda* were mere tracks, not marine vegetation, as has been suggested in the case of the first, or, in the second, the impression of the actual body of ciliated worms.

BIBLIOGRAPHICAL NOTICES.

Farm Insects: being the Natural History and Economy of the Insects injurious to the Field-crops of Great Britain and Ireland, and also those which infest Barns and Granaries. By JOHN CURTIS, F.L.S. Illustrated with numerous Engravings. 8vo. London: Van Voorst, 1883.

THE value of the work of the late John Curtis on Farm Insects is so generally recognized that we need do little more than call attention to this reissue of it in its original form. No doubt economic entomology has made considerable progress since the first publication of the book in its complete form in 1859; but while we may admit that this progress would enable us to correct some statements and to fill up gaps in the history of certain species which the author was compelled to leave, it is astonishing to notice how little the broad treatment of the subjects would need to be modified. The work of the great English entomologist was in fact so thoroughly done according to the lights of his day, that later writers have practically added but little to it, and we may say that the agriculturist need wish for no better guide to the history of those minute and often hidden enemies whose attacks are frequently so fatal to his interests; while to the entomologist, at any rate, this reprint of a classical work which has been long unprocurable will prove exceedingly welcome, and he will hardly be inclined to regret that the contents of the book have not been meddled with. The plates alone, executed in the author's happiest manner, are a delight to the entomological eye, quite apart from their practical usefulness; they are, as the publisher says in his "Advertisement," "so excellent and so full of detail" that their reissue to the public, with the accompanying text, not only needs no apology, but entitles him to the thanks of all interested in entomology.

John Curtis, as we all know, was so careful and conscientious a worker, that it is no great wonder if his labours in the department of agricultural entomology carried him so far in advance that even now we have little to add to his account of the natural history of the farmer's insect foes, and that all subsequent writers on the subject have been compelled to borrow largely from his pages. It is not difficult, in fact, to recognize the direction that an editor's labours would have to take should it ever be decided to produce a new edition of this book; his researches would have to be devoted chiefly to collecting the records of cases in which particular species had proved specially injurious, and the details of the application of new remedies, of which many, as may be seen from Miss Ormerod's useful little book, have been proposed with varying success, often involving the use of materials comparatively unknown when Curtis wrote. This new information might easily be worked up into the form of appendices or supplementary notes without interfering seriously with the original text, and changes of nomenclature, of which there are many, could be indicated in a similar manner.

Monograph of the British Aphides. By George Bowdler Buckton. Vol. IV. 8vo. London : Ray Society, 1883.

In this fourth volume Mr. Buckton concludes his monograph of the British Aphides, and supplements the descriptive portion with some general remarks, which will serve to direct the attention of students to the very interesting questions connected with the history of that remarkable group of insects.

The species here described are the British members of the tribes Pemphiginæ, Chermesinæ, and Rhizobiinæ ; they are treated in the same fashion as in the preceding volumes, and several of them are of special interest in connexion with M. Lichtenstein's theory as to the reproduction of Aphides. The views of that entomologist, which appear to be gaining ground, are quoted by the author in several places, notably in connexion with the genus *Phylloxera*, under which we find the translation of an excellent summary of his opinions furnished by Lichtenstein himself to Mr. Buckton (p. 63), which will be of great service to English readers.

As already stated, Mr. Buckton has appended to the systematic part of his work a discussion of various interesting questions connected with the natural history of Aphides in general, commencing with some remarks on the relation between Aphides and Ants—a subject upon which much has been written, often in a somewhat hyperbolical strain. Mr. Buckton apparently does not regard the extant evidence as sufficient to establish anything like a necessary relation between the Aphides and the Ants in whose nests they are sometimes found ; and certainly those writers who maintain that certain ants obtain nearly the whole of their sustenance from plant-lice are manifestly in the wrong. At the same time the existence of this curious relationship between insects of such different types is proved by the testimony of so many good observers, that we cannot deny it some considerable importance in the economy of the ants. Mr. Buckton's remarks are eminently suggestive.

The most important section of his supplementary matter, however, is that in which he deals with the reproduction of Aphides; and in the preparation of this he appears not only to have carefully gone through all the contributions of previous writers, but also to have entered personally upon a most elaborate investigaion of the anatomy of the reproductive organs in the different forms of these insects. This portion of Mr. Buckton's work is particularly valuable.

The succeeding section, relating properly to fossil Aphides, is rather discursive, and strikes us as perhaps hardly in place in connexion with a Monograph of British Aphides. The author here enters more or less into a discussion of the occurrence of fossil insects in sedimentary rocks and in amber, and finally describes and figures the Aphides occurring in the latter, those determined by Heer from the Tertiary deposits of Œningen and Radoboj, and finally the species obtained by Mr. Scudder from the Tertiary basin of Florissant, in the Colorado region. The last-mentioned forms have been determined and named by Mr. Buckton from Mr. Scudder's drawings.

The volume concludes with some practical remarks on natural and artificial checks to the increase of Aphides, and on preserving and dissecting these minute and delicate insects, which will prove of great service to intending students of the group, whose number we hope may be greatly increased by the facilities which Mr. Buckton's labours have offered to them in his present work. His carefully prepared descriptions and figures place in the hands of students a ready means of working out whatever is already known of the British forms of one of the most interesting and curious groups of insects, a group many members of which, from their wonderful fecundity, are among the most formidable foes of the farmer and the gardener, and which thus has as it were a double claim to our notice. In conclusion, we would heartily congratulate Mr. Buckton upon the completion of his work, which, although we know it to have been a labour of love, must nevertheless have tasked his energies severely.

MISCELLANEOUS.

On the Development of Balanoglossus. By William Bateson, Cambridge, England*.

An unlimited quantity of this remarkable form was easily to be obtained at half-tide all along the shores in the neighbourhood of Hampton, Virginia. The difficulties attending the investigation were far less than those that have been previously met with at other localities. Since the time during which I have been able to remain in America was exceedingly limited, I thought it best to confine my work at Hampton to the study of fresh specimens of the animal, and to the task of collecting and preserving them for subsequent

* Note from the 'Chesapeake Zoological Laboratory,' 1883.

examination by means of sections. My observations are therefore very meagre and inadequate, especially as regards the organogeny of the form, owing to the extreme scarcity of the larvæ. These important deficiencies I hope subsequently to supply when I shall have been able to examine my material by sectional methods. The general appearance of the Hampton form presents many points of slight divergence from the species common at Naples (*B. minutus*), so that at first sight the two animals seem very different; but whether the anatomy of this form is essentially different, I could not decide by examination of fresh specimens alone. The principal result of my work has been to show that the form common on the Chesapeake coast does not pass through the Tornaria stage, which has been described by previous observers as the larva of *Balanoglossus*. The eggs of this animal are opaque, yellowish-grey bodies, enclosed in a thin tough egg-shell which is quite transparent. Segmentation is begun by the appearance of a median furrow which divides the egg into two equal halves. This is followed by another median furrow at right angles to the first, forming four segments. In the next stage that I have been able to observe segmentation was complete, having probably proceeded in a regular manner, though this I have not been able to determine. One edge of the blastoderm is next flattened and gradually depressed, causing the embryo to take the shape of a concavo-convex disk. The concavity becomes gradually reduced in size as its edges grow together to form the blastopore, appearing at the same time to become thickened. This process is continued until the blastopore becomes exceedingly small; whether it subsequently disappears or not I cannot say until I have cut sections of it. I believe, however, that it becomes the anus, which at all events is found in the same position. As this gastrula becomes shut off it resumes the spherical shape and begins to rotate about the axis which eventually becomes the long axis of the animal, at the top of which the blastopore is placed. This rotatory movement is caused by a uniform covering of fine cilia. After rotating in this way for some few hours, the body elongates and a ring of large cilia appears surrounding the posterior end. The animal then swims round the egg, rotating at the same time on its long axis. A nearly median transverse constriction next occurs, which is followed by another one anterior to it, giving the body the appearance of being composed of three segments. The anterior segment becomes the proboscis, the middle one forms the collar, and from the posterior portion the rest of the body is developed. Within the anterior constriction the mouth is subsequently formed. At the anterior end of the proboscis a tuft of fine long cilia grows out as in the larvæ of many Chætopoda, &c. A pair of depressions are at the same time formed posteriorly to the collar in a dorsal position. These depressions form the first pair of gill-slits. In this condition the larva is generally hatched, though I have found individuals already free before the appearance of the transverse constriction. On hatching these larvæ are still quite opaque, and live buried in the muddy sand which the adults inhabit. In this condition the animal remains for some time, increasing in size, until it is about an eighth of an inch long, the proboscis being about half the total length of the body. The tip of the proboscis is used by the larvæ to attach themselves by suction to foreign bodies, though apparently no special suctorial organ exists. As the body grows, the posterior band of cilia becomes wider and the cilia themselves longer and coarser, while the direction of the band alters slightly. From the appearance of fresh specimens in this stage, treated with acetic acid, I believe that several pouches arise from the gut which probably are destined to form the other gill-slits; but this is quite uncertain, though of course sections will at once decide this question. I have been unable to procure any specimens older than these, and of the changes by which this larva becomes converted into *Balanoglossus* I can therefore say nothing. Possibly the animal remains in this condition during the winter and awaits the spring for its final development. I hope to be able to observe the subsequent stages at some future season.—*Johns Hopkins University Circulars*, Nov. 1883.

On the Development of the Branchia in the Cephalopoda. By M. L. Joubin.

The investigations of Kölliker upon the development of the Cephalopoda, while throwing much light upon the embryogeny of those animals, have nevertheless left in obscurity the origin of the organ of respiration. I have set myself, in the laboratories of M. de Lacaze-Duthiers, to fill up this gap by studying principally the *Sepia officinalis*, the eggs of which are easily procured.

The branchiæ of the embryo make their appearance at the beginning of the development in the form of two small buds, situated symmetrically with relation to the antero-posterior plane upon the middle of what will eventually become the posterior wall of the palleal cavity. The bud, produced by a pushing forth of the epithelial layer by the cells of the subjacent layer, soon elongates and forms a small well-differentiated eminence, rounded at the apex and attached by a broad base. I found it impossible, even in the youngest embryos that I could obtain, to ascertain the presence of vibratile cilia upon the branchia, although the palleal cavity is lined with them. The bud afterwards flattens so as to present two surfaces—a posterior one, applied against the visceral mass, and an anterior one, which is subsequently covered by the mantle which bounds the respiratory cavity superiorly.

Upon this little lamina, which is about $\frac{1}{3}$ millim. in length, a first horizontal fold appears towards the middle, then a second nearer to the point, then a third still nearer to the free extremity, and so on.

These folds form depressions upon one of the surfaces corresponding with elevations upon the other surface; the branchial bud has therefore become an undulated lamina; gradually other folds appear, always towards the point, while the whole organ at the same time increases in dimensions, so that a length of $1\frac{1}{2}$ millim. corresponds with a dozen folds. But the latter do not occupy the whole surface of the young branchia; a space is reserved along its two margins (the external and the internal), in one of which will be formed the efferent vessel, and in the other the special gland of the branchia.

One of these undulations, considered in its totality, may be regarded as a semicircle formed by three parallel curves of cells, a middle one enclosed between an external convex and an internal concave one. Supposing the two extremities of this arc fixed in the same plane, if growth took place with equal rapidity in the three layers of cells, we should soon have a large *cul-de-sac,* no longer a semicircle, but more or less conical and deep; but things go on otherwise—the cells of the middle layer increase in number, and push before them the epithelium forming the convex surface, while that which forms the concave layer is not modified. By advancing more and more by means of a terminal focus of cell-division, the median layer gives rise to a lamina clothed on its two faces by the convex epithelium. The cells of this lamina, which are at first contiguous, soon separate from each other, so as to form lacunæ, and, at certain points, vessels. From this it results that, as this process is repeated alternately to the right and left of the primary undulated lamina, we obtain sections of the branchia composed of a slightly undulated axis, from which issue, to the right and left alternately, laminæ which become longer and longer the further we go from the extremity of the branchia. A little later we easily distinguish a small muscular band, which follows the inferior margin of each of the laminæ composing the branchia and fixes it.

Each of the laminæ formed as I have just stated produces in its turn a series of undulations by becoming folded in the direction of its width. But in this case the undulations are much hollowed, and correspond with strong eminences on the other side; no new productions are formed at the expense of the median layer, which remains even throughout and preserves its two epithelia. These undulations start from the point of attachment of the lamina, to run, gradually diminishing, to the point where is the focus of increase and where the new folds are formed.

Lastly, in the adult we observe a third system of undulations, consequently of the third order, situated perpendicularly to the point of inflexion of the laminæ, the formation of which I have just described. These series of new folds only appear very late in the embryo; at the moment when, being on the point of quitting the egg, it measures about 15 millim. in length, we only see scarcely perceptible traces of them, but they become quite distinct when injections of the branchia are made, which, however, is a very delicate operation.

As regards the vessels of the branchia, the one which conveys the blood to it appears early at the commencement of the formation of the laminæ; it occupies nearly the centre of the organ, and is comprised within the base of the laminæ and the gland of the branchia, which is also distinctly marked at this period. The efferent vessel is formed upon the crest of the branchia and on the outer border of the laminæ; it is undulated, like the parts which bear it, and issues from the branchia at the base, to be continued by the auricle of the heart.—*Comptes Rendus*, November 12, 1883, p. 1076.

Injury sustained by the Eye of a Trilobite at the Time of the Moulting of the Shell. By Charles D. Walcott.

Mr. William P. Rust, of Trenton Falls, N. Y., called my attention some time since to the eyes of a small but very perfect specimen of *Illænus crassicauda*, from the Trenton Limestone, that he has in his beautiful collection of Trenton fossils.

The left eye is perfect: the visual surface is clearly defined, and in the sunlight almost translucent between the darker base and the curve of the facial suture above. The right eye at first sight appears to have been broken in working away the matrix; but a close examination shows, as Mr. Rust expressed it, that the eye had been put out while the animal was living. This is shown by the peculiar growth of the shell about the aperture formerly occupied by the visual surface of the eye. The margins are turned in, rounded, and contracted, and the size of the palpebral lobe materially lessened. An injury to the visual surface would scarcely produce this effect if the shell was hard. If slightly injured before the moulting of the shell the separation would be imperfect and the visual surface carried away with the old shell would leave a cavity around which the new shell would form, as in the eye before us. If injured before the new shell had hardened, that effect might be produced; but the probabilities are, that the loss of the visual surface occurred at the time of the moulting of the old shell.

Among the thousands of trilobites that have passed through my hands in which the eyes were preserved I have never noticed any distortion or injury that occurred during the life of the animal. In a few instances the shell of the pygidium of *Asaphus platycephalus* has shown evidence of local fracture that appears to have occurred during the life of the animal, but these were very unsatisfactory. To Mr. Rust's skill in working out the specimen described, and also in detecting the character of the injured eye, we are indebted for some positive information of an injury sustained during the moulting of the shell of a trilobite.—*Amer. Journ. Science*, Oct. 1883, p. 302.

The Pelagic and Deep Faunas of the two Lakes of Savoy (the Lac du Bourget and Lac d'Annecy). By Dr. O. E. Imhof.

The Lac du Bourget is 17 kilom. long and about 5 kilom. broad, and its depth is stated at 80–100 metres. The Lac d'Annecy measures 14 kilom. in length, and its greatest breadth is $3\frac{1}{2}$ kilom.; its greatest depth is estimated at 62 metres.

In the Lac du Bourget on the 5th October the author obtained at 20 metres *Daphnella brachyura*, Liev., *Leptodora hyalina*, Lillj., a

Bosmina, a *Cyclops*, and a *Diaptomus*. From 50 metres he got two more Cladocera, *Sida crystallina*, Müll., and *Daphnia hyalina*, Leyd. Of the Rotatoria his two new species, *Asplanchna helvetica* and *Anuræa longispina*, were pretty abundant. Of Protozoa a *Ceratium* and a new *Dinobryon* (*D. cylindricum*, which also occurs in the lake of Neuchatel) occurred. The Copepoda and *Daphnella brachyura* were most numerous in individuals, while the *Bosmina* occurred rarely. *Bythotrephes* appeared to be absent.

The pelagic flora consisted of numerous tufts of *Anabæna circinalis*, *Pleurococcus angulosus*, *Gallionellæ*, and *Fragillariæ*. The *Anabæna* bore numerous *Vorticellæ*, which never occurred on the *Pleurococcus*, a condition also observed by Forel in the lake of Geneva and by the author in the lake of Zug.

The bottom, at about 100 metres, between Petit Port and the Château de Bourdeau, furnished but few forms. A specimen of the blind *Asellus Foreli*, Blanc, bore many *Vorticellæ*. There was also a perfectly transparent *Cypris*. A rather large, fusiform, rather thick, pale reddish Rhabdocœlous Turbellarian formed a rather deep furrow in the mud when moving forward. Of Protozoa there were a *Cothurnia* with a yellow, sessile, beaker-shaped carapace, and a Rhizopod of the family Euglyphina, a *Cyphoderia*, Schlumb. (*margaritacea* ?).

The pelagic fauna of the Lac d'Annecy included:—Cladocera: *Daphnella brachyura*, Liev., *Daphnia hyalina*, Leyd. (the most numerous of the Cladocera); a *Bosmina* (rare here also); and *Leptodora hyalina*, Lillj.

Copepoda: a species of *Cyclops* and one of *Diaptomus*. *Bythotrephes* appears to be wanting here also.

Corethra-larvæ in considerable numbers.

Rotatoria: three species, *Asplanchna helvetica* (extraordinarily abundant), *Anuræa spinosa* (rare), and *Anuræa longispina* (less rare).

Protozoa: a species of *Dinobryon* and one of *Ceratium*.

The deep fauna at the same place, at 80 metres, was richer than in the Lac du Bourget. Colonies of *Fredericella* bore many examples of the Rotatorian *Floscularia proboscidea*, Ehr., together with four species of Infusoria, namely *Stentor cæruleus*, Ehr. (pretty abundant), two species of *Vorticellæ* (in considerable quantity), and *Epistylis* (*Opercularia*) *nutans*, Ehr. Other Protozoa met with were *Carchesium polypinum*, Ehr. (not uncommon), an *Amœba*, and the same *Cyphoderia* as in the Lac du Bourget.

Besides these, the author dredged up a species of *Pisidium* and *Asellus Foreli*; of the Cladocera, *Simocephalus vetulus*, O. F. Müll., and *Lynceus affinis*, Leyd.; of the Ostracoda, a species af Cypridæ; of the Copepoda, a *Canthocamptus*, probably undescribed. A dingy white *Hydra* also occurred.—*Zool. Anzeiger*, vi. no. 155, Dec. 10, 1883, p. 655.

An Instance of Sexual Colour-variation in Crustacea. By H. W. Conn*.

Differences in the colour of the two sexes among Crustacea are of very rare occurrence. Darwin in 'The Descent of Man,' chap. ix., refers to this fact and says he is acquainted with but two instances of this peculiarity. One in the case of *Squilla stylifera*, and a second in a species of *Gelasimus*, or fiddler crab, described by Fritz Müller as occurring in Brazil. A third and very striking instance is found in *Callinectes* (*Neptunus*) *hastata*, the common edible crab of our southern coast. There are a number of differences in the shape of the two sexes, but besides these they present a marked difference in colour. This colour-variation is confined to the first pair of thoracic appendages, the pair bearing the large chelæ. These appendages are of a yellowish brown on the upper surface, a whitish yellow on the outside, and of a brilliant blue on the inside and particularly at those parts which are protected from the light when the appendage is folded. It would seem therefore that this blue coloration was enhanced by not being exposed to light. The colour of different individuals is tolerably constant and uniform.

Between the colours of the male and female appendages considerable differences are discernible. The most noticeable difference is that the male appendage appears remarkably blue when compared with the female. This is due partly to the fact that the amount of blue surface in the male is much greater than in the female, and partly to the fact that the blue colour is of a much more brilliant hue. The blue colour in the male extends nearly to the tips of the two fingers of the chelæ, both the finger-like process of the propodite and the dactylopodite being largely coloured blue. The very tips are, however, of a brilliant purple. In the female these parts are of an orange hue, with not a trace of blue about them. The tips are also coloured purple, but not so brilliant a purple as is found in the male. In the male the blue colour extends partly upon the outer surface. In the female it is confined to the inner surface and only extends to the base of the dactylopodite. The outer surface of the dactylopodite and of the finger-like process of the propodite are in the male white, while in the female they are reddish orange. Upon the male appendage there is no orange colour as a rule.

These differences in colour are in all cases very marked, and will always serve to distinguish a male from a female appendage. No colour-differences are seen in any part of the crab except upon the first pair of appendages; and it is interesting to note that this sexual difference does not make its appearance till the crab reaches maturity. The chelæ of immature males and females cannot be distinguished from each other. Fritz Müller says that the same is true of the *Gelasimus* observed by him. On the other hand, considering the habits of Crustacea, these sexual differences can hardly be considered as the results of sexual selection.—*Johns Hopkins University Circulars*, Nov. 1883.

* Note from the 'Chesapeake Zoological Laboratory,' 1883.

On the Influence of Physico-Chemical Agencies upon the Development of the Tadpoles of Rana esculenta. By M. Emile Yung.

The author subjected tadpoles just hatched to the action of saline solutions of various strengths. The salts employed were obtained by the evaporation of the water of the Mediterranean, and the larvæ were placed in solutions of 1, 3, 5, 7, and 9 per 1000, which were renewed at the same time in all the vessels, and the whole were in other respects placed under precisely the same conditions. As a general result, M. Yung states that *the tadpoles are developed the more slowly the more considerable the degree of saltness of the water.* In the solution of $\frac{9}{1000}$ no transformation took place, though some tadpoles lived long enough to acquire hind limbs. In a solution of $\frac{10}{1000}$ very young tadpoles die in a few hours; older ones survive for a few days.

The author remarks upon the importance of placing *equal numbers* of individuals in each vessel in experiments of this kind. On placing 4, 8, 12, 16, &c. tadpoles of the same age and the same brood in a series of vessels, and keeping them under precisely the same conditions, *their development is found to be slower in proportion to the number living together*, which confirms the results obtained by Semper for the *Limnææ*.

Finally, M. Yung subjected young tadpoles, which normally live in quiet water, to continuous agitation in a vessel containing two litres of water regularly renewed and suitable food. The agitation of the liquid was felt to the bottom of the vessel, but reached its maximum at the surface, where the tadpoles, on coming up to the air, had to struggle against strong waves. Under these conditions the eggs developed well; but the newly hatched tadpoles, being too feeble to seize their prey in so disturbed a medium, died of hunger, unless care was taken to give them daily a few moments of repose to take their food. The mortality was always greatest in the first few days; it diminished immediately the first transformations were effected. Of twenty individuals placed in the vessel in April, eight have furnished little frogs, and on the 1st August only one had not completed its metamorphoses.

If these agitated tadpoles be compared, at different periods, with others of the same brood developing in quiet water, *it is found that the development of the former is slower* (the test-tadpoles were all transformed on the 15th July), *that they are less pigmented*, which indicates bad nutrition (the tadpoles which do not eat much are always pale); and, lastly, *that their tails are relatively more developed, especially in width*, which is explained by the greater use they are obliged to make of these organs in struggling against the waves.—*Bibl. Univ., Arch. des Sciences*, pér. 3, tome x. p. 347, October 15, 1883.

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VII.—*On a Specimen of* Pecopteris (? polymorpha, *Brongn.*) *in Circinate Vernation, with Remarks on the Genera* Spiropteris *and* Rhizomopteris *of Schimper.* By ROBERT KIDSTON, F.G.S.*

[Plate V. fig. 1.]

ALTHOUGH the beautiful specimen which forms the subject of this communication does not throw any additional light on the growth of fossil ferns, yet as none of the figures of circinate vernation with which I am acquainted surpass this example, I have ventured to give a short description and a figure of it.

The fossil is about 3 inches long; but if we measure the full length of the circinately rolled-up portion as if it were straightened out, it is fully 6 inches in length. The specimen is, however, incomplete at its lower extremity; so its original size cannot now be ascertained.

The rachis is thick and still shows slight traces of the little scales with which its surface was once covered. The inner side of the rachis bears about thirty-three circinately rolled-up pinnæ.

* Read before the Royal Physical Society of Edinburgh, December 19, 1883.

These show nothing further than the midribs of the pinnules, which appear as strongly defined ridges. There is no evidence in the specimen itself to indicate the species to which it belongs; but from the occurrence of fragments of *Pecopteris polymorpha*, Brongn., on the same slab *, it probably belongs to that fern.

The specimen is in the collection of the Geological Survey of Great Britain, to whom it was presented by Mrs. Stockhouse Acton.

My thanks are due to Dr. A. Geikie, F.R.S., Director-General of the Geological Survey of Great Britain, for permission to describe this interesting fossil.

Position and Locality. From the Coal-measures, Leebotwood, about nine miles from Shrewsbury.

As a means of giving a definite place in the classification of fossil plants to such fossils as that just described, Schimper has proposed the genus *Spiropteris* †, in which he places those specimens of ferns that do not afford sufficient characters for the determination of the species to which they belong. For fossils of this nature the genus is very useful, as it gives a fixed, though provisional, position to many interesting specimens which cannot be specifically associated with the fully-developed frond.

Several very interesting examples of *Spiropteris* have been already described.

In 1828 Brongniart ‡ figured a *Spiropteris*-condition of *Pec. Miltoni*, Artis (=*Pec. polymorpha*, Brongn.), which shows a few of the pinnæ spirally coiled.

Göppert gives a figure of circinate vernation of *Pec. Jägeri* §. It exhibits a very young condition of probably a whole frond. He also gives another specimen of *Spiropteris* on his plate xxxvi. fig. 8.

Probably the most interesting figures of *Spiropteris* are those given by Germar ||, which he named *Selaginites Erdmanni*. These, as Schimper has pointed out, are not Lycopods, but young ferns ¶, and referable to *Spiropteris*. Though the specimens are of considerable size, they show merely the early condition of a large frond. The dense cover-

* Not shown in the figure.

† Traité d. Paléont. Végét. vol. i. p. 688, pl. xlix. (1869).

‡ Hist. d. Végét. Foss. p. 334, pl. cxiv. fig. 1.

§ Die fossilen Farrnkräuter, p. 368, pl. xxii. fig. 6 *a* (1836).

|| Die Verst. d. Steinkohlengebirges v. Wettin u. Lobejun, p. 61, pl. xxvi. (1844).

¶ Schimper, Traité d. Pal. Vég. vol. i. p. 689.

ing of scales with which they are bedecked, gave rise to the mistaken opinion that the fossils were Lycopods and the scales their leaves.

A small specimen of *Pec. arborescens*, Schl. sp., in circinate vernation has been figured by Geinitz in his 'Verst. d. Steinkohlenform. in Sachsen' *.

Sir C. J. F. Bunbury described a very curious fossil fern from the Sydney Coal-field, Cape Breton †, which showed portions of a frond in circination.

This specimen beautifully exhibits numerous long scales on the rachis. Some of the lateral pinnæ are fully expanded; but these, unfortunately, are not sufficiently well preserved to enable one to determine the species to which the fern belongs. Bunbury regarded it as a *Pecopteris* standing in the neighbourhood of *P. plumosa*, Brongn.

From the scales on the rachis Mr. R. Brown, who found the specimen, "supposed it to belong to a peculiar species of *Lepidodendron*" ‡; but there can remain no doubt as to the fossil being a fern referable to *Spiropteris*.

The same writer in 1857 § figured and described a specimen of *Neuropteris* (probably, as suspected by the author, *Neur. gigantea*, Sternb.) circinately coiled, from Glodwick Colliery, near Oldham, Lancashire.

Examples of *Neuropteris* in this condition are even more rare than those of *Pecopteris*.

The figure which accompanies his paper shows a very perfect example with the usual accompanying scales on the rachis.

Mr. T. Stock has shown me a small circinate specimen of *Neuropteris* from the Coal-measures near Dysart, Fife; but this one probably belongs to *N. Loshii*, Brongn., as it was associated with that fern.

In the 'Illustrations of Fossil Plants,' which consists of a reproduction of a number of unissued plates prepared by Lindley and Hutton for their 'Fossil Flora,' three good figures of *Spiropteris* are given ‖.

Plates xlv. and xlvii. are referable to *Neuropteris*, but of that on pl. xlvi. the genus is uncertain¶.

* p. 24, pl. xxviii. f. 10 (1855).

† Quart. Journ. Geol. Soc. vol. viii. p. 31, pl. i. (1852).

‡ *Ibid.* vol. viii. p. 32.

§ Bunbury, "On a remarkable Specimen of *Neuropteris*, with Remarks on the Genus," Quart. Journ. Geol. Soc. vol. xiv. p. 243.

‖ Edited by G. A. Lebour, Newcastle-on-Tyne, 1877.

¶ See Crépin, Révision de quelques espèces figurées dans l'ouvrage intitulé "Illustrations of Fossil Plants," Soc. roy. de botanique de Belgique, vol. xx. part ii. p. 25 (1881).

In a paper on *Sphenopteris affinis*, L. & H.*, Mr. C. W. Peach gives some good figures of the young state of this fern. His figures 6 and 7 show very clearly the characteristic dichotomy of the rachis of this species.

The above is a list of the chief Palæozoic examples of *Spiropteris* which have been figured and described; and it is remarkable, that though ferns are our most common class of fossil plants in the Carboniferous formation, specimens showing their early stages of development are so seldom met with.

There is another group of fossils which, though very similar in general appearance to *Spiropteris*, are most probably quite different in nature. For these Schimper has proposed the name *Rhizomopteris* †.

In this genus Schimper places the specimens which Geinitz has figured ‡ as *Selaginites Erdmanni*, believing them to be fern-rhizomes; and certainly the fossils in question have a great resemblance to such structures.

There can be no doubt as to Geinitz's plants being quite distinct from those originally described under the same name by Germar §.

Schimper also places in his *Rhizomopteris* the *Selaginites uncinnatus*, Lesqx. ‖.

Lesquereux, though he says the specimen cannot positively be referred to the Lycopodiaceæ, still keeps it separate from *Rhizomopteris*, and includes it in *Lycopodites* (*L. uncinnatus*) ¶.

I am inclined to regard this fossil as the rhizome of a fern; and the spiral terminations of several of the branches, which appear to be the chief character that prevents Lesquereux from regarding his plant as a rhizome, are most probably spirally-coiled young fronds springing from the points of the branchlets of the rhizome.

From the nature of the fossil and the state of its preservation, there is, however, room for difference of opinion as to its true nature.

* Quart. Journ. Geol. Soc. vol. xxxiv. p. 131, pl. viii. figs. 5–7.

† Schimper, *l. c.* vol. i. p. 699 (1869).

‡ Geinitz, *l. c.* pl. i. figs. 5 and 6.

§ Geinitz figures in his 'Flora der Kohlenform. v. Hainichen-Ebersdorf u. Flöher-Guckelsberg,' p. 56, pl. xiv. fig. 20, a plant which he also names *S. Erdmanni*. This appears to be only a badly-preserved *Lepidodendron*.

‖ Geol. Survey of Illin. vol. ii. p. 446, pl. xli. fig. 3 (1866).

¶ 'Coal-Flora of Pennsylvania,' p. 359 (1880).

VIII.—*On a new Species of* Schutzia *from the Calciferous Sandstones of Scotland.* By ROBERT KIDSTON, F.G.S.*

[Plate V. fig. 2.]

Schutzia Bennieana, n. s., Kidst.

Specific character.—Fruit campanulate, composed of linear lanceolate bracts; pedicels of fruits short and placed spirally on the axis.

Remarks.—The specimen on which the above description is based, shows the upper portion of a fructification, but its lower part is broken over, so that its original length cannot now be determined. The part which has been preserved is $3\frac{3}{10}$ inches long.

Only three fruits are attached to the stem, the terminal one and two immediately beneath it.

Below these are seen the scars from which four others have fallen. The spiral arrangement of the fruits is clearly shown by the position of those which still remain, that on the right being placed at about a third of the circumference of the stem distant from the one to the left hand.

The bracts of the little cones are about half an inch long, narrow, and terminating in a sharp point, and they appear to have had a central keel. From the compressed state of the fossil it is impossible to make out their arrangement clearly, but they were probably placed in a few spirals.

The stalks to which they are attached are short, being barely, in the longest and lowest example, the fifth of an inch long. The main axis is irregularly striated longitudinally.

Affinities.—This plant is closely related to *Schutzia anomala*, Geinitz †, from the Rothliegenden of Ottendorf, near Braunau, Bohemia ‡; but the differences between the Permian and the Scotch plant are such as to necessitate a specific designation.

* Read before the Royal Physical Society of Edinburgh, December 19, 1883.

† Geinitz, Neues Jahrbuch, 1863, "Ueber zwei neue dyadische Pflanzen," p. 525, pl. vi. figs. 1, 2, 3.

‡ Göppert also notes the occurrence of this plant at Neurode, Silesia, see 'Die foss. Flora der permischen Formation,' pl. xxiii. figs. 1–6, pl. xxiv. figs. 1, 2, 3, 5 (1864–5). The plates for this work were prepared before the publication of the paper by Geinitz, though not issued till after; hence the name which Göppert had proposed for this plant (*Anthodiopsis Beinertina*) appears on his plates; *Schutzia anomala*, Gein., is used in his text. See also Göppert, Fos. Flora d. Uebergangsgebirges, p. 214, (1852).

They agree in the spiral arrangement of the little cones, in their being short-stalked, and in the furrowed stem, as also in the angle made by the pedicels and the stem.

The form of the fruit is, however, essentially distinct.

In *Schutzia anomala* they are globular, and consist of numerous and much shorter keeled scales, which are similarly arranged in a few short rows. These often appear blunt, but Geinitz thinks this bluntness may arise through a bending of their apices.

Schutzia Bennieana teaches nothing as regards internal structure; but in *S. anomala*, Geinitz thought he could discover, "at the base of the inner side of the fruit-scales, the appearance on each side of a longitudinal depression, which corresponded to the two seeds in the fruit-scales of Coniferæ."

In addition to the plates of *Schutzia* given by Göppert, he also figured another fossil, which he named *Dictyothalamus Schrollianus* *.

This he thought might belong to *Schutzia anomala*, the latter being the female, the former the male plant. These occurred together and often on the same slab.

The central part of *Dictyothalamus* is composed of small elongated roundish bodies, which Göppert thought were the seeds.

He believed these fossils might belong to the *Nœggerathiæ*, but Geinitz regarded them as coniferous.

As there occurred with the specimens *Nœggerathia* (*Cordaites*) and Coniferæ of different genera, as *Walchia piniformis*, Schl., sp., and *Ullmannia*, no light is thrown on the affinities of *Schutzia* by the vegetable remains with which it was associated.

But that it does not belong to *Walchia* or *Ullmannia* is pretty certain, as the fruits of both these plants are now well known†.

Schimper unites *Dictyothalamus Schrollianus*, Göpp., with *Schutzia anomala*, Geinitz ‡, and regards the *Schutzia* as the female, and the *Dictyothalamus* as the male plant. The

* Göppert, Die fos. Flora d. perm. Formation, p. 164, pl. xxiv. figs. 4 & 6, pl. xxv. figs. 1–4.

† Göppert figures and describes what he believes to be the fruit and male flowers of *Walchia piniformis*, in Die fos. Flora d. perm. Form. p. 239, pl. xlix.—the cones, figs. 1–10; the male flowers, figs. 11–14. See also Weiss, Flora d. jüng. Stk. u. d. Rothl. p. 179, pl. xvii. fig. 1. The fruit of *Ullmannia* was described as far back as 1828 by H. Bronn, in Leonhard's Zeitschrift für Mineral. Band ii. p. 509, pl. iv., under the name of *Cupressus Ullmanni*. Göppert also figures, in his Permian Flora, similar cone-like fruits (pl. xlv. figs. 24, 25).

‡ Schimper, Traité d. Paléont. Végét. vol. ii. p. 358.

structure in the latter which Göppert believed to be seeds, Schimper thinks are stamens, and this view I am inclined to adopt. These remarks show that the real affinities of *Schutzia* are very obscure.

Schimper regarded these fossils as belonging to a "coniferous plant, which was altogether paradoxical and without any analogy, either fossil or recent"*.

Although this is not a very satisfactory manner of disposing of *Schutzia*, the conclusions arrived at by Schimper may possibly be correct, though we have little positive evidence to support this opinion.

Large coniferous stems, with their internal structure beautifully preserved, are of frequent occurrence in various parts of the Calciferous Sandstones of Scotland. The remains of coniferous trees also occur in rocks of similar age in different parts of the globe; but notwithstanding their wide geographical distribution and frequency of occurrence, there is nothing definitely known regarding their fruit or foliage.

Prof. Dawson has described and figured a small coniferous-like branch from Tatamagouche (Carboniferous formation), which he has named *Araucarites gracilis*†. This, he thinks, may possibly belong to his *Dadoxylon materiarum*‡.

Some botanists regard the Trigonocarpons as the fruit of Conifers, but this opinion is not universally accepted§.

The absence, however, of conclusive evidence as to the fruit and foliage of Palæozoic Coniferæ is not so surprising when we consider that the ancient pines most probably occupied the uplands of the then existing continents, and only the stems and larger branches would be able to resist the abrasion and decay of their long journey from the uplands to the flats, where mud or sand was being deposited; and as proof of this, many of the stems of these trees are found imbedded in sandstone quarries, where they have been drifted.

The undoubted occurrence of the genus *Schutzia* so low down in the geological scale is of considerable importance; the discovery in the Calciferous Sandstones of a plant so closely related to a Permian species, is almost without parallel.

* *Loc. cit.* p. 358.

† Dawson, 'Acadian Geology,' 2nd edit. p. 474, fig. 159 A (1868).

‡ Dawson, *l. c.* p. 424.

Stur also gives, in his 'Culm Flora' (p. 81, pl. xiv. fig. 4), a small figure and description of a fossil he has named *Pinites antecedens*. The specimen is small, and its union with the Coniferæ appears a little uncertain.

§ Since writing the above, Prof. Williamson, in his Address at the British Association, has given a *résumé* of this subject ('Nature,' Sept. 20, 1883).

The small fossils which I previously described and placed in the genus *Schutzia* are different from the present example, and their real claim to this genus may perhaps be open to question*.

Schutzia Bennieana comes so near the Permian species, that it is only after very careful consideration I have given it a specific designation †.

It gives me pleasure to name this plant after Mr. J. Bennie, to whom I owe so much for kind assistance in many points connected with my study of fossil botany.

Position and Locality.—In bituminous shale, water of Leith, opposite Kate's Mill, Midlothian; Calciferous Sandstone series. Collected by Mr. James Bennie.

IX.—*On the Fertilization of the* Florideæ. By Prof. F. Schmitz.

[Concluded from page 29.]

V.

The preceding description has by no means exhausted all the modifications presented by the process of fertilization and fructification in the Florideæ, as is shown by the fact that in almost every fresh genus that I investigated I detected new modifications of the previously observed processes. It is also sufficiently demonstrated by Bornet's statements with regard to *Spyridia*, *Callymenia*, *Crouania*, and other genera which I have hitherto been unable to examine. But the most important modifications of these processes have probably been shown in the foregoing in the described genera, which belong to the most different families of the Florideæ.

From this description it appears, however, that *throughout*, in the fertilization of the Florideæ a material connexion exists between the male cell, the spermatium, and the cell which is developed into the sporigenous tissue of the cystocarp (the "nucleus" of systematic botany). A fertilizing influence of

* Trans. Roy. Soc. Edinb. vol. xxx. p. 545, pl. xxxi. figs. 10, 11, 12.

† Schimper thinks the (?) *Trigonocarpus Rœssleri*, Gein. (Neues Jahrb. 1867, p. 288, pl. iii. fig. 4), is an analogous fruit, but specifically distinct (Traité d. Paléont. Végét. vol. ii. p. 358).

the union of spermatium and carpogonium upon a third, *distant* cell is never to be observed *.

The general result of the above description may, however, be briefly summarized as follows :—In all Florideæ a single male cell (*spermatium*) unites by open conjugation with the apex of the trichogyne of the female cell (the *carpogonium*); the cell-nucleus of the spermatium passes into the carpogonium and unites (apparently) with the cell-nucleus of the carpogonium. Then the ventral part of the carpogonium separates as a fertilized ovicell from the trichogyne. The fertilized ovicell, however, now becomes further developed in many different ways. It either grows directly into a bundle of branched ooblastema-threads, which finally produce the carpospores directly from their cells; or these threads enter into union with neighbouring cells of the sterile thallus-tissue for the obtentation of more abundant nourishment, and then produce the spores from their cells; or the individual cells of these threads enter into conjugation with cells of the thallus-tissue rich in contents, and afterwards produce pluricellular complexes of spores; or the cells of these ooblastema-threads evacuate the whole of their plasmatic contents, or a portion of

* As is well known the great accordance in the development of the fruit in Ascomycetes and Florideæ has already been repeatedly indicated in literature. This agreement appears particularly great since Stahl has succeeded in the Collemaceæ in tracing back the development of the apothecium to a "procarpium" of which the trichogyne is fertilized by spermatia. The preceding investigations on the fructification of the Florideæ have shown that a material connexion always exists between the two sexual cells, which concur in the act of fertilization, and the cell which in consequence thereof develops into the spore-fruit. The question now arises whether analogous conditions do not prevail also among the Collemaceæ and other similar Ascomycetes (and Ascidiomycetes?); whether in these also the fertilized "trichogynal cell" does not develop into an ooblastema-thread, and then one of the ooblastema-cells does not unite with one or more neighbouring auxiliary cells for the development of the tuft of filaments of the "ascogenous hypha." Various things seem to me to be in favour of this supposition, especially the great morphological agreement which exists in so many points between the Florideæ and Ascomycetes. But nothing certain for the decision of this question can be derived from the results of the extant investigations (of Stahl, Borzi, and Fisch), as these investigations started from quite different points of view, and therefore have not gone sufficiently in detail into the points which here essentially come under consideration. My own observations upon the development of the Collemaceæ have not as yet been sufficiently detailed and complete to render any decision of this question possible.

Further investigations will have to decide whether really (as it appears) perfectly analogous processes occur in the fructification of the Ascomycetes (and Ascidiomycetes?) and in that of the Florideæ, or whether in these groups of Thallophytes, notwithstanding external resemblance, essential differences prevail in the processes in detail.

them, under open conjugation, into analogous auxiliary cells, and these then produce pluricellular complexes of spores; or, finally, the fertilized ovicell itself empties the whole or a part of its contents, without any formation of branched ooblastema-threads, into the auxiliary cells immediately bordering it, and thereby causes these to produce pluricellular complexes of spores, or branched sporigenous filaments.

However, this last mode seems essentially to be confined to Florideæ with very dense and firmly closed cell-tissue (Gigartineæ, Rhodymenieæ, Spharococceæ, and Rhodomeleæ); but the development of widely spreading ooblastema-threads is chiefly proper to the Cryptonemieæ, Gelidieæ, and Squamarieæ, in which either the whole thallus, or the fructifying part of it, displays a gelatinous, soft or loose tissue. The fertilized ovicell becomes developed directly into simple bundles of sporigenous threads generally in such forms, the monœcious individuals of which develop numerous carpogonia and spermatia in close proximity, and make sure of the fertilization of numerous carpogonia by the quantity of these spermatia, so that it is not necessary, as in the preceding cases, in which the fertilizations of the carpogonia only take place singly, to use these up, and make them available in as many ways as possible.

In all these different cases, however, it comes finally to the formation of a sporigenous tissue-body of very variable size and form. This is sometimes seated upon the exterior of the thallus of the parent plant, or is enclosed, without any special envelope, in the tissue of the thallus; but generally this tissue-body forms a fruit-nucleus ("*nucleus*"), and is surrounded by a very variously formed envelope called the "pericarp" or "involucre." Both these forms are indicated in descriptive algology indifferently as "cystocarpia;" but such cystocarpia (as, indeed, appears from the foregoing description) are of very different origin in the different groups of the Florideæ, so that, for example, the cystocarpia of *Nemalion*, *Naccaria*, *Dudresnaya*, *Glœosiphonia*, *Chilocladia*, *Nitophyllum*, *Peyssonelia*, *Corallina*, and *Chondrus* are by no means equivalent in respect of their origin. Nevertheless the circumstance that in all these cases the sporigenous mass of tissue, whether naked or furnished with a wall, rises on the thallus of the parent plant as an independent fruit-body, sufficiently justifies the uniform designation of all these different forms of fruit.

If we compare the different process-details of the fructification with one another, it appears that, in the simplest cases, the ooblastema-cells directly and immediately produce the carpospores. In other cases these ooblastema-threads, for the purpose of readier and more abundant nourishment, first of all enter into union with the cells of the sterile thallus-tissue. In a later stage of fuller differentiation, special thallus-cells, the auxiliary cells, are already previously prepared for this purpose and abundantly furnished with contents; but the ooblastema-cells enter into a closer and closer union with them, which may advance to complete conjugation. Finally, the ooblastema-cell unites completely with the auxiliary cell to form a single cell, which now, for its part, takes on the function of the ooblastema-cell and carries it to completion; and at length there is no longer any development of pluricellular ooblastema-threads, but the ovicell itself (or a part of it) unites with the auxiliary cell. Thus, as the development of a simple process of nutrition, there results a process which, in its whole course, agrees perfectly with those processes which are designated as sexual processes of fecundation.

If in order to proceed quite securely we limit the discussion to the processes of fructification in *Glœosiphonia* which are comparatively easy to ascertain, the union of ooblastema-cell and auxiliary cell here shows all the characters of a sexual fertilization. The conjugation of the two cells and the transfer of the protoplasm of the ooblastema-cell take place in exactly the same way as in recognized processes of fecundation, for example in the fertilization of *Pythium* * and *Ancilistes* †; nay, it may even be ascertained that the cell-nucleus of the ooblastema-cell unites with the cell-nucleus of the auxiliary cell, as finally, after the evacuation of the ooblastema-cell into the auxiliary cell, only a single cell-nucleus is present. The consequence of this union of the two cells is, however, a new and very rapid growth of the auxiliary cell quite different from its previous growth, a growth which never occurs without a union of the auxiliary cell with the ooblastema-cell. Thus therefore *all* the conditions ‡ are fulfilled that can be required of a process which is to be regarded as a process of sexual fecundation; and certainly no one would

* De Bary, Beitr. zur Morphol. und Physiol. der Pilze. 4te Reihe.

† Pfitzer in Monatsb. Akad. Wiss. Berl. 1872, pp. 393, 394.

‡ If we leave out of consideration all inconceivable, mysterious, metaphysical qualities of sexuality only the following remain as common characters of all vegetable processes which have hitherto been by common consent recognized as sexual:—union of two (similar or differently developed) cells with fusion of the cell-nuclei, and a new and peculiar mode of growth of the conjugation-cell, which, without this conjugation, does *not* take place. In other respects the generally recognized processes of fecundation (to say nothing of the disputed ones) display the most multifarious differences.

hesitate to interpret this process in *Glœosiphonia* as a sexual act, if it were not that in the developmental cycle of this species there was already another process which must be regarded as a process of sexual fecundation. To assume a double act of fecundation in the developmental cycle of a single species is, however, in complete opposition to botanical conceptions,—that contradicts all tradition *.

But before the power of facts tradition must always give way. As a matter of fact the state of the case is that in *Glœosiphonia* the above-mentioned processes possess all the characters which have elsewhere been reckoned requisite for a sexual act. There is therefore nothing for it but either to embrace as a character in the definition of a sexual act, that it *can* occur only *a single time* in the developmental cycle of a species, and that of two processes, both of which possess the other requisite characters of an act of fecundation, only one is to pass as a sexual act; or to admit that in the developmental cycle of *Glœosiphonia* (and all analogous Florideæ) a sexual act is twice intercalated, a fecundation of the auxiliary cell following after the fecundation of the carpogonium†.

But if this amalgamation of ooblastema-cell and auxiliary cell must be recognized as a sexual act, there is thus thrown a very peculiar light upon sexuality in general. For here, among the Florideæ, the comparison of the different genera shows distinctly that the process which in *Glœosiphonia* displays all the characters of a sexual act, is to be referred, as it is distinctly observed in variously nearly allied Florideæ, to a simple act of nutrition, and has evidently originated from such a simple act of nutrition. In this way then sexual fecundation is tacked on to the simple vegetative nutrition of one cell

* Certainly Pringsheim (Jahrb. f. wiss. Bot. xi. pp. 18 *et seqq.*) has already distinguished, in the fecundation of the Thallophyta (and especially of the Florideæ), two distinct acts, which he indicates as "conjugation" and "connubium." But this distinction simply divides the individual sexual act into two steps, while in the present case we have actually to do with two separate sexual acts.

† At the same time it appears from the preceding description that the actual course of the second process of fecundation is somewhat different in different cases. In some instances (*Glœosiphonia*) this process takes on the form of a complete union of two cells; in other cases (Ceramieæ &c.) it would almost appear, as has already been pointed out, that in place of such an open conjugation the protoplasm (or the cell-nucleus) of one cell migrates through the separating membrane into the other cell. In this case the process of fecundation would display exactly the same differences which have been recently demonstrated by De Bary (Beitr. zur Morphol. und Physiol. der Pilze: 4te Reihe) in the fecundation of the Peronosporeæ (*Pythium, Phytophthora, Peronospora*).

by another *, and appears merely to be a peculiar further development of this process, which is so widely diffused in vegetable life, while otherwise sexual fecundation stands rather isolated among the processes of organic life.

But whether we regard this second act of conjugation in *Glœosiphonia* and other Florideæ as a sexual act or not, in any case this process has only been originated within the group itself †; in the simplest forms it is entirely wanting.

In these (*Nemalion* &c.) the course of development of the individual species proceeds as follows:—the vegetative plant proceeds from the germinating carpospore and develops sexual cells, after which the fecundated female cell grows upon the

* That by this I by no means wish to assert that the fertilization of a (female) cell by another (male) cell consists simply in the accession of fresh nutritive material (as indeed has been formerly asserted) needs no express declaration. In all cases the male cell, as also the female cell, is a formed *living* cell-body and not a "lump" of *lifeless* nutritive material.

† Just as this second sexual act has made its original appearance within the group Florideæ, so, evidently, may it also disappear again in the course of the development of this group, or instead of it the original first sexual act may be eliminated. In the first case the course of development of the species implicated will simply revert to the original form, and such forms might be hardly distinguishable from the primary simplest forms. On the other hand, if the first original sexual act disappears, the course of development of the species must thereby acquire a completely different aspect. For in this case the formation of spermatia must have entirely ceased; but, in exchange, either the individual spermatium mother-cells would develop directly into (simple or branched) male cell-filaments, which would fecundate the auxiliary cells, while the carpogonia entirely disappear, or no spermatium mother-cells at all would be formed, but instead of them the carpogonia would grow out directly into male cell-filaments (of course without preliminary development of a trichogyne). The final result, however, would be the same in both cases, namely the fertilization of auxiliary cells (produced sometimes from terminal cells, sometimes from joint-cells of the thallus-filaments) by the cells of shorter or longer, simple or branched cell-filaments.

This elimination of the first sexual act has, however, never been actually traced in the domain of the Florideæ so far as our present observations extend. It appears, however, to be realized among the Ascomycetes. Here, as already pointed out (p. 81, note), the Collemaceæ present such great analogies with the Florideæ that one may well assume that the formation of the fruit is in them brought about in the same manner as, for example, in the Cryptonemieæ. But in other Ascomycetes the above elimination of the first act of fertilization seems actually to have taken place in the course of development of the species, so that in these the second sexual act of the Florideæ has alone persisted as the sole sexual act; the mother-cell of the ascogenous hyphæ therefore represents a Floridean auxiliary cell (*Ascobolus* &c.). Nay (if, indeed, the extant descriptions really exhaust the actual processes), this second sexual act appears to have also frequently disappeared, so that the auxiliary cell, whether distinguished or not by its peculiar form from the other cells of the hypha, becomes developed apogamically into the spore-fruit.

parent plant itself into a spore-fruit, which, by the development of carpospores, brings back the whole developmental cycle again to the starting-point. This is exactly the same course that is displayed by the development of the Liverworts and Mosses,—the same sequence of alternating generations as in those cases. Thus it becomes easy in the course of development of these simplest Florideæ to recognize the alternation of generations of the Archegoniata, which, as is well known, we have accustomed ourselves to regard as the typical mode of vegetable development, so much so, indeed, that only the recognition of this alternation of generations in the individual case explains and renders intelligible the course of development in the group of plants in question *.

But these simplest Florideæ are approached most closely and distinctly, as has been shown above, by the other forms with more complicated fructification, and precisely by this distinct approximation enable us also to recognize clearly and distinctly in their development the above alternation of generations, although it has been here somewhat complicated by the intercalation of the second sexual act †.

But, independently of this complication, the above typical alternation of generations makes its appearance quite undisturbed and distinctly recognizable in the course of development of many Florideæ. In many other forms, however, still further complications of it occur, the vegetative generation dividing, as in the true mosses, into prothallium and leafy plant (*Batrachospermum* &c.). In numerous other forms, moreover, the tetraspores or bud-formations of various kinds are developed in the vegetative generation as accessory organs of increase, whether they are produced upon the sexual individuals themselves (*Cruoriopsis cruciata*, Duf., *Petrocelis Ruprechti*, Hauck, &c.) or confined to special neutral individuals (as in most Florideæ).

Lastly, in many Florideæ there seems to be associated with the above typical alternation of generations (corresponding to

* That in such an explanation of the course of development of a group of plants we have to do with a perfectly analogous process, as in the explanation of the more complicated forms of flowers of Phanerogamia, which are explained and made intelligible (see Schmitz, 'Die Familiendiagramme der Rhöadinen') by comparison with other previously known flowers, will not be hard to see upon consideration.

† In these forms of the Florideæ (*Glœosiphonia* &c.) we can if we like distinguish series of three generations, as here the female sexual cell of the simpler Florideæ (*Nemalion* &c.) is replaced by two cells, the carpogonium and the auxiliary cell, and between these a new third generation is intercalated.

the alternation of generations of the Archegoniata) * a still further complication, a regular alternation of sexual individuals and (single or numerous successive) tetraspore-individuals being developed. This at least seems to be indicated with great probability by the fact that, of many short-lived Florideæ, sexual plants are to be met with only at particular seasons, while neutral plants are to be found either throughout the year or, at any rate, for a considerable time. Certainly, however, no instance of such a regular alternation of neutral individuals and sexual individuals (which in itself might be regarded as a particular kind of alternation of generations) has hitherto been demonstrated with certainty by observation.

VI.

The whole process of development of the simplest Florideæ approximates them, as has repeatedly been pointed out in literature, very nearly to the Chlorophycean group of the Coleochæteæ.

In both groups of Algæ the entire body of the plant is composed of ramified cell-filaments with apical growth, and the joints of which are never transversely divided, and these are more or less closely pressed together laterally. In both groups of Algæ the sexual cells originate from terminal cells of these cell-filaments †. Small terminal cells develop from their entire protoplasm single naked male cells; individual larger terminal cells become inflated into female cells, and extend from their apex a longer or shorter thin trichogyne. But in the Coleochæteæ these trichogynes open at the joint; the protoplasm of the female cell, even before fecundation, cuts off an unserviceable portion as a directive body, and evacuates this through the open apex of the trichogyne; further, in the Coleochæteæ the naked male cells are spontaneously motile by means of two cilia; and, lastly, in the Coleochæteæ the fertilized ovicell first of all passes into a resting state, and only after this period of rest develops a cell-body, which leads to the formation of motile "carpospores."

All these last-mentioned points, to which may be added, as less important matters, the difference of the assimilation

* Pringsheim some time since (Jahrb. für wiss. Bot. Bd. xi. p. 6) expressed an essentially different view of the sexual alternation of generations of the Florideæ. But it would lead us too far to enter here in any detail into the differences of the two conceptions.

† In the position of the sexual cells, according to the extant statements (Pringsheim, in Jahrb. für wiss. Bot. Bd. ii.), some species certainly show a different character, inasmuch as they develop their sexual cells from joint cells of the thallus-filaments.

colouring-matters and of the solid assimilation-products, are of sufficient weight to make an *immediate* annexation of the Florideæ to the Coleochæteæ impossible; but, on the other hand, the agreement pointed out between the two forms is so great that, in the natural system of the Thallophyta, the simplest Florideæ may be arranged next to the Coleochæteæ, and consequently the whole of the Florideæ or Rhodophyceæ next to the Green Algæ or Chlorophyceæ *.

On the other hand, I can by no means regard another relationship of the Florideæ, so often dwelt upon of late, the relationship to the Bangiaceæ, as so close as is supposed. This group of Algæ which we have lately been accustomed simply to arrange among the Florideæ, on the ground of Berthold's observations †, must, in my opinion ‡, be quite separated from the Florideæ, and for this reason no reference has been made to it in the above description. For the establishment of this opinion the most important points in the development of the Bangiaceæ which distinguish them from the Florideæ may therefore be briefly indicated here.

In the first place, the construction of the thallus of the Bangiaceæ is essentially different from that of the Florideæ. In the Bangiaceæ transverse division of the joint-cells takes place in an unlimited degree, and numerous longitudinal divisions of the cells are produced by partitions which occupy the organic middle line of the cells, neither of which ever happens in the Florideæ. In consequence of this also the thallus of the Bangiaceæ, so long as it does not actually represent a simple cell-filament, can never be reduced to a mere system of branched fibres. Further, the vegetative thallus-tissue of the Bangiaceæ is also always quite destitute of the remarkably characteristic primary pits of the Florideæ, which are formed in unity in the organic centre of each newly formed dissepiment.

Further, the sexual cells of the Bangiaceæ are formed from any cells of the thallus, while in the Florideæ they are formed exclusively from terminal cells of longer or shorter cell-filaments. For the formation of the spermatia, in most Bangiaceæ (*Bangia*, *Porphyra*), the individual thallus-cell breaks up by repeated division by means of dissepiments perpendicular to each other into a pluricellular complex of small cells,

* An opposite opinion has been recently expressed by Falkenberg (Schenk, Handb. der Bot. Bd. ii. pp. 252, 253) and Berthold ('Fauna und Flora des Golfes von Neapel, VIII. Bangiaceæ,' p. 22).

† Mittheil. aus der zool. Station zu Neapel, ii. pp. 78 *et seqq.*, and Fauna und Flora des Golfes von Neapel, Bd. viii.

‡ See Schmitz, Chromatophoren der Algen, p. 3, note 1.

which are all alike, and each of which gives origin to a single spermatium *; in the Florideæ the spermatia always originate only from superficial cells, terminal cells, or branch-cells of the cell-filaments of the thallus †. In the Bangiaceæ the individual thallus-cells, without distinction, become converted into female cells, extending a short diverticulum on the outer surface of the thallus, which usually hardly even distantly resembles the trichogyne of the always terminal carpogonia of the Florideæ ‡. In the act of fecundation in the Bangiaceæ, moreover, the whole protoplasm of the spermatium, except a very small residue §, passes over into the female cell, which then retracts the above conjugation-process, and becomes converted into the fertilized ovicell, without separating off the directive body which is so characteristic of the Florideæ. Lastly, in the Bangiaceæ, this fecundated ovicell either becomes directly the spore (*Erythrotrichia*, according to Berthold, *l. c.* p. 17), or breaks up by repeated division into a complex of more or less numerous cells, all of which give origin to single naked spores; a sporigenous tuft of threads with a sterile central cell, as in the cystocarp of the Florideæ, is here never produced.

In my judgment, all these peculiarities distinguish the Bangiaceæ very essentially from the Florideæ ||, which, with all their other differences of construction, display a complete agreement in the points mentioned. Consequently the Ban-

* In *Erythrotrichia*, however, according to Berthold (Bangiaceæ, p. 13) the spermatia are formed from marginal cells of the individual joint-cells of the thallus.

† I would lay less stress upon the further fact that, as Berthold states (*l. c.* pp. 12, 13), in the Bangiaceæ the spermatia always contain formed chromatophores with pyrenoids [see Schmitz, 'Die Chromatophoren,' &c.], while in the Florideæ, the spermatia, so far as my present observations extend, are always destitute of chromatophores.

In passing it may be here once more (see Schmitz, 'Chromatophoren der Algen,' p. 39, note 1) indicated that Berthold everywhere confounds the pyrenoids of the chromatophores with the cell-nuclei, but has overlooked the true cell-nuclei in the cells of the Bangiaceæ. I took up the investigation of this question again after the appearance of Berthold's recent memoir, in which his previous statements are simply repeated; but this time also I find my above-cited statements about the cell-nuclei and pyrenoids of the Bangiaceæ completely confirmed.

‡ Compare figs. 2, 4, 12, 13, 23, and 24 in Berthold, *l. c.*

§ See also Berthold's statements, *l. c.* pp. 14 *et seqq.*

|| Berthold (Bangiaceæ, p. 21) thinks, on the contrary, that the characters of structure and growth of the thallus, with reference to which the Bangiaceæ stand quite isolated among the Florideæ, but correspond with the Ulvaceæ and Ulotricheæ (*l. c.* p. 1), are of no importance with regard to the systematic position of the Bangiaceæ.

giaceæ must at least be separated as a distinct group from the very coherent group of the Florideæ*.

But it seems to me that this peculiar group of the Bangiaceæ cannot be placed close to the Florideæ as the most nearly allied group in the natural system. The agreement of the Bangiaceæ with the Florideæ depends fundamentally only upon a few subordinate points. In both groups of Algæ the chromatophores are generally not chlorophyll-green, but coloured with various shades of red or brown; in both groups of Algæ the male cells are not motile (so far as is at present ascertained †); in both groups of Algæ the fertilized ovicell produces, without a period of rest, usually a considerable number of asexual spores. Nearly all these individual characters also occur in other groups of Algæ (*e. g.* even the Dictyotaceæ likewise possess motionless male cells, for which reason they have also sometimes been regarded as Florideæ); but, in my judgment, they do not of themselves alone establish an *immediate* relationship between the Bangiaceæ and Florideæ. I rather believe, as I have already stated briefly elsewhere ‡, that, in the natural system of the Thallophyta, the Bangiaceæ are to be placed alongside of the Chlorophycean group of the Schizogoneæ (*Prasiola, Schizomeris, Schizogonium, Palmoglœa, Porphyridium*); while the Florideæ certainly attach themselves through the Coleochæteæ to the main stem of the Algæ, the Chlorophyceæ §, but are separated by a sufficiently wide gap from these Chlorophyceæ, and represent a group sufficiently large, numerous in forms, and peculiarly developed to be judiciously distinguished as a special, independent section of the Algæ, the Rhodophyceæ.

The results of the extant investigations upon the fructifi-

* Even the conception of the Bangiaceæ as a peculiar branch of the Florideæ, which has branched off from the very base of this great Algal stem, cannot prevent the otherwise so perfectly harmonious ramification of this Algal stem from being seriously interfered with by this very branch.

† Hitherto the faculty of free locomotion is ascribed only to the spermatia of *Erythrotrichia* by Berthold (*l. c.* p. 13). But at present we are quite without any statements in what manner this locomotion is effected. Compare herewith the above statements (p. 9, note *) upon the spontaneous mobility of the spermatia of the Florideæ.

‡ Schmitz, 'Chromatophoren der Algen,' p. 3, note 1.

§ By this arrangement the relationship of the Florideæ with the Bangiaceæ, so far as this actually exists, is also expressed, in my judgment, in a perfectly satisfactory manner; for by the approximation of the Florideæ to the Coleochæteæ the former also join on to the other groups of the Chlorophyceæ, and thereby also to the Bangiaceæ. Nevertheless the Bangiaceæ and Florideæ are certainly here torn more widely asunder than has usually been the case of late.

cation of the Florideæ furnish also some contributions to the classification of this section of the Algæ.

At present, as is well known, we have only the commencement of a natural system of the Florideæ. Our present knowledge of the group, which includes such an abundance of forms, is still too imperfect for it to be possible as yet to establish a natural system of these Algæ. For the present we must make artificial systems answer our purpose, and these are now founded entirely upon the structure of the mature cystocarp (J. Agardh), a preponderant consideration of the growth of the thallus (Nägeli) having proved to be unsuitable. A consistent carrying through of this principle of division, however, frequently tears the nearest allies wide apart (*e. g.* *Delesseria* and *Hydrolapathum*, *Chylocladia* and *Lomentaria*, *Griffithsia* and *Bornetia*, &c.).

For the advancement of the natural system of the Florideæ an exact investigation of the processes in the fructification of the different individual forms is, in my opinion, essentially necessary. It would, however, lead me too far to enumerate here in detail the results which I think I can deduce from my investigations towards the natural system of the Florideæ. The more general results of this kind have already had expression given to them in the above statement in the arrangement of the groups. A more thorough-going representation of them will only be indicated when we have been able to investigate exactly a far greater number of forms than at present with regard to their fructification.

EXPLANATION OF THE PLATES.

Plate I.

Fig. 1. *Batrachospermum moniliforme*, Roth.
(Picric-acid-Hæmatoxyline preparation.)

Apex of the carpogonial branch with the carpogonium already fertilized; trichogyne separated off from the ventral part of the carpogonium, and the latter sprouting forth laterally. The hypogynal cell develops beside the older ramified side-branch a new lateral sprout as the foundation of a new sterile enveloping branch. In the ovicell, the hypogynal cell, and the branch-cells of both sides the nucleoli of the cell-nuclei are intensely coloured; within the trichogyne the protoplasm encloses a number of intensely coloured granules (derivatives of the cell-nucleus of the female cell?). × 800 diam.

Figs. 2–4. *Chantransia corymbifera*, Thur.
(Spirit-material, relaxed in water and coloured with hæmateine-ammonia.)

Fig. 2. In the fertilized carpogonium the trichogyne is separated off by means of the membranous stopper within the neck of the trichogyne. The fecundated ovicell forms an offshoot upwards, which has already been separated off by a transverse wall. × 800.

Fig. 3. Next stage of development. Besides the terminal offshoot a second offshoot is commenced laterally. × 800.

Fig. 4. Further stage of development. × 800.

Figs. 5–7. *Scinaia furcellata*, Bv.

(Spirit-specimen.)

Fig. 5. Young carpogonial branch. In the terminal carpogonium the formation of the trichogyne has just commenced. The hypogynous cell has already formed a marginal cell for the production of the hypogynous disk. On the lowest cell of the carpogonial branch has commenced the sprouting forth of the enveloping filaments, which subsequently close together to form the fruit-wall. × 800.

Fig. 6. Four-celled hypogynous disk, with the separated ventral part of the just fecundated carpogonium. × 800.

Fig. 7. The fertilized ovicell (still furnished at the apex with the closed neck of the trichogyne) has projected at one side, and developed an abundantly ramified tuft of ooblastema-threads (the formation of which by no means proceeds from the cells of the hypogynous disk, as has hitherto been supposed). × 800.

Figs. 8–15. *Glœosiphonia capillaris*, Carm.

(Spirit-material.)

Fig. 8. Young procarpium from the side. *b*, basal cell of the whole procarpial branch, the penultimate cell (*a*) of which (the terminal cell is bent laterally and in the figure concealed by the cell *a*) becomes the auxiliary cell. This basal cell bears, as a side-branch, the three-celled carpogonial branch, the terminal cell of which has already developed a long trichogyne, while the hypogynous cell has projected very much on one side (*h*) and become abundantly filled with protoplasm. The second cell of the procarpial branch bears laterally a sterile side-branch. × 800.

Fig. 9. Young procarpium from below. *b*, basal cell of the entire procarpial branch, the joint-cells of which are separated by differently inclined transverse walls, and have nearly all formed sterile lateral branches, while the penultimate cell (*a*) becomes the auxiliary cell. The basal cell bears as a side-branch the three-celled carpogonial branch, the hypogynous cell (*h*) of which has here remained much smaller than in fig. 8. × 800.

Fig. 10. Carpogonial branch. In the fertilized carpogonium the ventral part is separated and has grown out into a single ooblastema-thread (*c*), which, near its base, has developed a side-branch (*c*′). The ventral part of the carpogonium is completely emptied; the hypogynous cell (*h*) has still abundant contents. × 800.

Fig. 11. Auxiliary cell (*a*) at the apex of the procarpial branch (seen from below) in open conjugation with the ooblastema-cell (*e*). × 800.

Fig. 12. Procarpial branch seen from below. The basal cell (*b*) and the neighbouring joint-cell each bear laterally a carpogonial branch, of which in the figure only the lowest cell (*d*) is shown. The auxiliary cell (*a*) had entered into conjugation with the ooblastema-cell (*e*), and, after the transference of the whole of the protoplasm from *e*, has again closed up as an independent cell with abundant contents. × 800.

Fig. 13. Apex of the procarpial branch with the fertilized auxiliary cell *a*, from the side. × 800.

Fig. 14. The same. The fertilized auxiliary cell (*a*) has separated off outwards the central cell of the spore-complex. × 800.

Fig. 15. The same, further stage of development. The central cell separates off successive marginal cells. × 800.

Figs. 16–19. *Dudresnaya purpurifera*, J. Ag.
(Spirit-material.)

Fig. 16. Carpogonial branch, with the apex bent inwards. From the ventral part of the fertilized carpogonium, which is already separated off, an ooblastema-thread grows out, and takes a direction towards the auxiliary cells, which are formed by the terminal cells of short side-branches of the carpogonial branch. × 800.

Fig. 17. The same. From the ventral part of the fertilized carpogonium two short ooblastema-threads have grown out and have conjugated with certain (one or two) auxiliary cells. One of these short filaments pushes out a side-branch (*c*), which grows out into the neighbouring thallus-tissue. × 800.

Fig. 18. The apex of an ooblastema-thread growing close past an auxiliary cell, which here forms the terminal cell of a special branch. × 800.

Fig. 19. Later stage of development of fig. 18. The growing apex of the ooblastema-thread has cut off a joint-cell, and this has entered into conjugation with the auxiliary cell. Afterwards the ooblastema-cell has formed a diverticulum outwards, and separated this off as an independent cell for the formation of the spore-complex. × 800.

Figs. 20 and 21. *Dudresnaya coccinea*, Crouan.
(Spirit-material.)

Fig. 20. The apex of an ooblastema-thread has grown close past an auxiliary cell, which here forms a joint-cell in a special branch; the separated joint-cell of the ooblastema-thread enters into conjugation with this auxiliary cell, the two neighbouring cells of which are also richly filled with protoplasm.

Fig. 21. A further stage of development. The joint-cell of the ooblastema-thread (*c c*) has formed outwardly an offshoot (*c'*), which grows into a side-branch of the ooblastema-thread, and also two lateral offshoots (*e*, *e*), which apply themselves to the auxiliary cell externally, and grow round it, to give origin afterwards to the spore-complex of the cystocarp. × 800.

Fig. 22. *Dumontia filiformis*, Grev.
(Spirit-material.)

Carpogonial branch, bent into a hook. The formation of the trichogyne has already commenced on the terminal carpogonium. × 800.

Plate II.

Fig. 23. *Calosiphonia finisterræ*, Crouan.
(Treated with picric acid and hæmatoxylin.)

Three-celled carpogonial branch. The lowest cell is much enlarged, like an auxiliary cell, but does not function as such. From the separated ventral part of the fertilized carpogonium three ooblastema-threads grow forth and diffuse themselves into the neighbouring thallus-tissue. × 800.

Figs. 24–27. *Naccaria hypnoides,* J. Ag.

(Material in spirit.)

Fig. 24. Young carpogonial branch (*b, d, e*) with incurved apex. Its basal cell (*b*) bears laterally two branch-cells (*a*), which subsequently develop into auxiliary cells. × 800.

Fig. 25. Later stage of development. The cell *d* of fig. 24 has formed laterally a branch-cell, *f*; the cell *e* has divided itself by an oblique transverse wall into the terminal cell *g* and the joint-cell *e*, so that now the cells *b d e g* form the uncinately incurved carpogonial branch. × 800.

Fig. 26. Further stage of development. The cells *d, e,* and *f* have repeatedly branched and formed a small-celled hypogynous cell-complex. The cell *g* has become developed into the carpogonium, and upon this, after fertilization, the trichogyne has become separated off from the ventral part. × 800.

Fig. 27. A still later developmental stage. The ventral part of the fertilized carpogonium has entered into conjugation with the basal cell (*b*) of the carpogonial branch, and now puts forth an ooblastema-thread (*c*). *t*, remains of the trichogyne, which is here very transitory. (The fertilized ovicell also enters into conjugation with the auxiliary cells *a* in fig. 24 through short processes in a very variable manner, after which fresh ooblastema-threads originate from the conjugation-cell; these processes, however, have been omitted from the figure for the sake of distinctness.) × 800.

Fig. 28. Diagram of the cell-division in the procarpium (median longitudinal section) of *Chondria, Polysiphonia,* and other Rhodomeleæ.

b, cell of the central axis of the procarpial branch; *a*, unpaired marginal cell of this, from which in the first place the curved carpogonial branch, *e e e c*, grows forth as a terminal growth, while laterally one or more branch-cells, *d*, are produced; these sometimes (as in *Chondria tenuissima*) ramify very abundantly, and form a complex of short, closely adpressed, *sterile* cell-filaments. The cell *a* itself subsequently becomes the auxiliary cell, and, after the fertilization of the carpogonium (*c*), is fertilized by the separated ventral part of this carpogonium, with which it is in contact at the time of fertilizable maturity. From the cell *a* the sporigenous filaments then shoot forth, while the cell-series *e e c*, as well as the sterile tuft of filaments of the cell *d*, disappears.

Figs. 29–33. *Chylocladia kaliformis,* Hook.

(Material in spirit.)

Fig. 29. One of the short-jointed cell-filaments, which, meeting at the apex, constitute the growing vertex of the branches of the thallus. The joint-cells of this cell-filament branch outwards to form the large-celled layer of the wall of the hollow joints of the thallus. From the branch-cell of the sixth joint-cell there shoots forth laterally an uncinately curved carpogonial branch. Drawn without the camera.

Fig. 30. The sixth joint-cell of fig. 29, with the adherent carpogonial branch, more highly magnified and drawn with the camera. The newly-formed trichogyne of the carpogonium strongly inflated at its base on one side. *b*, supporting cell of the carpogonial branch. × 800.

Fig. 31. Young rudiment of a cystocarp seen from the outside of the thallus. The shaded cells represent the carpogonial branch : *c*, the ventral part of the carpogonium, the trichogyne of which was segmented off after fertilization and has perished; the dotted cell, *b*, the supporting cell of the carpogonial branch. *a*, the auxiliary cell, which bends towards the fertilized ovicell (*c*) with a broad conjugation-process ; *m*, one of the large cells of the wall of the thallus-joint, which has separated off the auxiliary cell (*a*) externally as a daughter-cell. This entire cell-group is covered by numerous small marginal cells, which the neighbouring cells have separated off, and which form the first rudiment of the future wall of the cystocarp. × 300.

Fig. 32. An auxiliary cell with a broad curved conjugation-process, seen from the side. × 800.

Fig. 33. Carpogonial branch with fully-developed carpogonium. A spermatium has conjugated with the apex of the trichogyne. × 800.

Fig. 34. *Callithamnion gracillimum*, Harv.

(Material in spirit.)

Procarpium. On one of the uppermost joint-cells of a completed branch of the thallus there stand in a whorl the sterile branch-cells (*b*), the two auxiliary cells (*a*), one of which has also segmented off a cell (*d*) on its outer side, and the three-celled carpogonial branch (*e e c*). × 800.

Fig. 35. *Pterothamnion plumula*, Näg.

(Osmic acid and hæmatoxylin preparation.)

Procarpium. The basal cell (*b*) of a frond-pinna bears upon one side the curved four-celled carpogonial branch, and on the other side the auxiliary cell (*a*). The latter has curved over towards the upper surface of the basal cell, and so comes in contact with the ventral part of the carpogonium, which has already separated from the trichogyne, as the fertilized ovicell, by means of a very short and dense closing-plate (*p*). × 800.

Fig. 36. *Polysiphonia atrorubescens*, Grev.

(Picric acid and hæmatoxylin preparation.)

Young procarpium in median optical longitudinal section. On the joint-cell *b* of the central axis the unpaired marginal cell *a* has segmented off a terminal offshoot, which already consists of two cells, and by the development of further transverse walls in the terminal cell will grow into the curved carpogonial branch of the fertilizably mature procarpium (fig. 28). × 800.

Figs. 37 and 38. *Plocamium coccineum*, Lyngb.
(Spirit-material.)

Fig. 37. Young fruit-rudiment at the period of fertilizable maturity. A spermatium has conjugated with the extended trichogyne. × 150.

Fig. 38. Longitudinal section through a still younger fruit-rudiment, the apex of the trichogyne of which has not yet got free. An internal tissue-cell (*a*) has developed, as a secondary side-branch, a three-celled carpogonial branch (*e e c*), and itself become developed into the auxiliary cell, extending a conjugation-process towards the ventral part of the carpogonium. The trichogyne is much inflated in a clavate form above the neck before, breaking through the surface of the thallus with its dense cuticle, it protrudes as a long thin hair. × 400.

Fig. 39. *Caulacanthus ustulatus*, Kütz.
(Spirit-material.)

Longitudinal section through a young fruit-branch: *m m*, central axis. A side-branch of this central axis bears laterally on a joint-cell (*d*) the carpogonial branch (*e e c*). The lowest cell of this grows into a sterile rhizoidiform thread. The uppermost cell has developed into the carpogonium; its ventral part has become segmented off after fertilization, and has grown out into a single ooblastema-thread, which, branching abundantly, coils itself about the central axis. At × originated another ramified side-branch of the ooblastema-thread, which spread out upon the under surface of the central axis, but has been omitted in the figure for the sake of distinctness. × 400.

X.—*Contributions to the Knowledge of the Freshwater Sponges.* By Dr. F. VEJDOVSKY, of Prague. *With Remarks by* H. J. CARTER, F.R.S. &c.

[Plate VI.]

THE above is a translation of the Title of a memoir communicated by Dr. F. Vejdovsky to the Society of Science in Prague, on the 12th October last, and since printed in the Bohemian language, with the following *Résumé* in German:—

RÉSUMÉ*.

In my monograph of the freshwater sponges of Bohemia† I left two questions, among others, open, to be answered by subsequent investigations.

The first question relates to the multiform "*Ephydatia*

* Translated from a separate impression of the Memoir sent by the author to Mr. H. J. Carter, F.R.S.

† "Revisio Faunæ Bohemicæ. Pars I. Die Süsswasserschwämme Böhmens." Von Dr. Franz Vejdovsky in Prag (mit 3 lithographirten Tafeln). Abhandl. d. k. Böhm. Gesellsch. der Wiss. Folge 6, Band xii.

Mülleri," of which I distinguished "Forma A," "Forma B," and "var. *astrodiscus*." From observations made recently from fresh materials on "Forma B," this must be recognized as a distinct "good" species, for which I propose the name of *Ephydatia amphizona*.

The other question relates to the external parenchymatous envelope of the gemmules. I had previously found this in most of the indigenous species—*Euspongilla lacustris*, *E. jordanensis*, and *Ephydatia fluviatilis*. It remained still undecided whether corresponding envelopes were present on the gemmules in "*Ephydatia Mülleri*" and *Trochospongilla erinaceus*.

Having been able during the last vacation to investigate the above-mentioned forms in the fresh state, I can now furnish satisfactory information upon this question also.

I. *Ephydatia amphizona* (syn. *E. Mülleri*, Forma B) was obtained from the Juvorka brook near Soběic (Ostroměř), with the same characters that I have described in my monograph. Nevertheless the structure of the gemmules is quite different, and divergent from all allied forms. Fig. 2 shows a nearly median longitudinal section through a gemmule. In this we see the following layers:—

1. Externally, an outer layer of amphidisci (*a*), which project with their columns and distal terminal disks freely from the parenchymatous layer (*b*), while the proximal terminal disks are inserted into the upper parenchyma.

2. A tolerably thick parenchymatous layer (*b*) contains in its base the other layer of amphidisci (*c*), which is closely applied to

3. The brown chitinous membrane (*d*).

4. The inner space of the gemmule contains the germinal corpuscles (*e*).

Consequently *Eph. amphizona* is especially distinguished by the double layer of amphidisci in the parenchymatous envelope of the gemmules from *Eph. Mülleri*, var. *astrodiscus*, which, as I have recently convinced myself, possesses only a single layer of amphidisci in a feeble parenchymatous layer. As this latter form is also characterized by the form and habit of the exclusively hispid skeleton-spicules, it may be indicated by Lieberkühn's original name, *Ephydatia Mülleri**.

Whether the form indicated in my monograph as "*Eph. Mülleri*, Forma A," and as characterized by the peculiarly formed amphidisci, is to be regarded as a variety of the above-

* [*M. mirabilis*, Retzer, presents "a triple armature of amphidisci," according to Marshall, in a paper of which a translation will appear in our next number.—Ed.]

mentioned species, or as a distinct species, I cannot at present decide with certainty.

II. *Trochospongilla erinaceus* was found in cushion-like stocks in a deep side-water of the Elbe, near Neratovic. The inferior layers of the lamellæ contain extraordinarily numerous gemmules, seated close together, as shown in fig. 3. The longitudinal section through a gemmule (fig. 5) presents the following interesting characters:—

1. The inner chitinous membrane is very thick and layered (fig. 5, *c*).

2. The very depressed amphidisci (*b*) are in direct connexion with the chitinous membrane.

3. The layer representing the parenchymatous envelope of the other Spongillidæ is peculiarly modified in *Trochospongilla*. When the surface of the gemmule is examined it appears to be composed of five- or six-sided prismatic spaces (fig. 4). Longitudinal sections, however, show that this layer consists of tall hollow columns (fig. 6), which are divided by transverse walls into a number of air-chambers. The walls are firm, not very flexible, shining, and probably composed of a chitinous substance. The interior space becomes filled with air.

The whole of this outer envelope evidently forms an aerostatic apparatus as a means of the more ready transportation of the gemmule, and perfectly corresponds to the natatory rings of the statoblasts of the freshwater Bryozoa.

Whether the North-American species with smooth-edged amphidisci, *Meyenia Leidii* and *M. gregaria*, possess corresponding envelopes, must be ascertained from fresh material. I cannot detect the air-chamber layer in the dry *Meyenia Leidii* transmitted to me for comparison by the kindness of Mr. H. J. Carter.

III. *Ephydatia fluviatilis*, aut., I have also obtained from the neighbourhood of Soběic (Ostroměř), out of stagnant water, and found that it agrees perfectly in its characters with the sponges of the same species that I have described in my monograph.

By the kindness of Mr. H. J. Carter also, I have been enabled to compare the English specimens of this species with our indigenous ones, and from this comparison it appears that the English "*Meyenia fluviatilis*, Carter," is identical with my *Ephydatia fluviatilis*.

EXPLANATION OF PLATE VI.

Fig. 1. *Ephydatia amphizona*, n. sp.; gemmule very slightly magnified.

Fig. 2. The same species. A nearly median longitudinal section (magn.

Zeiss V. oc. 2, obj. C). *a*. External amphidiscus-layer; *b*. Granular parenchymatous layer; *c*. Inner amphidiscus-layer; *d*. Chitinous membrane; *e*. Germinal corpuscles.

Figs. 3–6. *Trochcspongilla erinaceus*, Ehr.

Fig. 3. Arrangement of the gemmules in the intermediate layers of the lamellæ. *a*. Air-chamber layer, representing the natatory ring of the statoblasts of the freshwater Bryozoa; *b*. Chitinous capsule; *c*. Aperture of the gemmule.

Fig. 4. Structure of the air-chamber layer on the surface.

Fig. 5. Median longitudinal section through a gemmule (magn. Zeiss V. oc. 2, obj. C). *o*. Aperture; *a*. Air-chamber layer; *b*. Amphidiscus-layer; *c*. Chitinous capsule; *d*. Germinal corpuscles.

Fig. 6. Longitudinal section of the air-chamber layer (magn. Zeiss, oc. 2, obj. E). *a*. Air-chambers; *b*. Amphidiscus-layer.

Remarks by H. J. Carter, F.R.S. &c.

The foregoing translation of a "*Résumé*" in German, which is appended by Dr. Franz Vejdovsky to his "Contributions to the Knowledge of the Freshwater Sponges," read at the Society of Sciences in Prague on the 12th of October last, and subsequently published in the Bohemian language, is of much interest, because it points out additional instances of what has been seen in other freshwater sponges, viz. *Parmula Batesii*, *Spongilla nitens*, and *S. alba* ('Annals,' 1881, vol. vii. pp. 99, 89, and 88, pl. v. figs. 1 and 3, respectively), together with a new variety in structure. Thus, in his *Ephydatia amphizona* (syn. *Eph. Mülleri*, forma B) we have an illustration (Pl. VI. fig. 2) of what occurs in the statoblasts of the two former, viz. a layer of statoblast-spicules on each side of the "crust" ('Annals,' *l. c.* p. 83), here composed of the "microcell-structure" (*ib. ib.* pl. v. fig. 2, *a*); while in his *Trochospongilla erinaceus* (*Spongilla erinaceus*, Ehr.) is another example of what occurs in *Spongilla alba* ('Annals,' *l. c.* p. 88), viz. a mixture of spicules with the "microcell-structure," but in a *new* form,. that is, instead of the crust being composed of microcell-structure charged with statoblast-spicules only, as in *Spongilla alba*, it is made up of comparatively *large* cells, like that in *Spongilla nitens*, &c. ('Annals,' *l. c.* pl. v. fig. 3, *i*), arranged in a columnar form, but traversed by full-sized skeleton-spicules of the species, and finally united to a layer of birotulates which are fixed to the "chitinous coat" (Pl. VI. figs. 5 and 6), yet so tenderly that, whether on account of this or the intermingling of the ends of the skeletal spicules which project beyond the cell-structure with the rest of the sponge, it very often happens that, in endeavouring to extricate the whole statoblast, the cellular crust &c. remains, while the chitinous coat and its layer of birotulates (amphidiscs) come away without it.

At least this is the result of my examination of several of the statoblasts taken from specimens of this sponge which Dr. Vejdovsky kindly sent me; but of course I am aware that in his illustration (Pl. VI. fig. 5) the *simple* fact of the arrangement of the parenchyma around the statoblast in hexagonal columns perpendicularly to the layer of birotulates on the chitinous coat alone is represented.

As yet I have been able to see this arrangement in fragments only, partly from the cell-structure being so intricately traversed by the skeletal spicules of the species and partly from its diffuse extension here and there beyond the surface of the capsule, recalling to mind that which is seen in *Spongilla fragilis*, Leidy = *S. Lordii*, Bk., to which Mr. Potts of Philadelphia directed my attention in the slide of this species which he kindly sent me in 1881.

Being better informed now on the subject than I was when I stated that *Spongilla erinaceus*, Ehr., of central Europe was "identical" with *Meyenia Leidii*, Bk., of Pennsylvania in North America ('Annals,' 1883, vol. xii. p. 331), I am now able to point out that they are different, viz. that whereas the crust in *Meyenia Leidii* is composed of microcell-structure enveloping the layer of birotulates which is fixed to the chitinous coat and separately surrounded by a capsule of smaller-sized spicules than those of the skeleton, although of the same form, viz. more or less spined and abruptly pointed, that of *Trochospongilla erinaceus* is surrounded by the comparatively large-cell structure first pointed out by Dr. Vejdovsky (*l. c.*), traversed by the long, fusiform, spined, sharp-pointed skeletal spicules of the species, as above described. In the American variety (for we can hardly call the differences specific, although it should be considered distinct and still retain its original name) the crust is sharply defined and separated from the surrounding spicular layer, while, as we have seen, in *Trochospongilla erinaceus* it is traversed by the skeletal spicules of the species which, with their outer points and diffuse cellular parenchyma here and there, intermingle with the surrounding tissue of the sponge. As I have before stated, however ('Annals,' *l. c.* p. 331), the first specimen of *Meyenia Leidii* from the Schuylkill river, kindly sent me on a slide by my friend Mr. Potts, bears, in addition to the smaller spicules *around* the statoblast above mentioned, others, viz. skeletal ones, almost identical with those of *Trochospongilla erinaceus*, thus still keeping up the almost endless variety in character of the Spongida generally. Other peculiarities of *Trochospongilla erinaceus* are the grey instead of the usual yelk-like colour and substance of the germinal contents of the statoblast;

the larger size of the "spherical cells" containing the germs, and their comparative tenacity, so that even in the broken section after desiccation these contents present a granular appearance instead of the usual homogeneity, from the unruptured state of these cells.

Through the great kindness of Dr. Vejdovsky I am in possession not only of a copy of his publications on the Freshwater Sponges of Bohemia, but of specimens mounted and unmounted of *Ephydatia amphizona* and *Trochospongilla erinaceus*, so that I am able to confirm the interesting facts which he has stated and illustrated respecting these sponges.

While on this subject, I would add that on the 29th of November last I received for examination some specimens of the bottom-sediment of some lakes near Pictou, in Nova Scotia, from Mr. A. H. McKay, B.A., B.Sc., Principal of the Pictou Academy ; and in that of "Earltown Lakes" I found, besides spined skeletal spicules, birotulates identical with those of *Meyenia Leidii*, together with others like those of the North-American form of *Spongilla lacustris* and those of the statoblasts &c. of Mr. Potts's ? *Meyenia crateriformis*, so that, in a geographical point of view, the freshwater species of Pennsylvania are in all probability to be found also in Nova Scotia.

P.S.—Since the above was written I have also received from Mr. Henry Mills, of Buffalo, N. Y., a letter dated 25th December last, in which he states the same fact of some of the North-American freshwater sponges as that from Bohemia, described and illustrated above by Dr. Vejdovsky under the name of *Ephydatia amphizona*. Mr. Mills's letter is accompanied by two specimens, viz. one from Ischua Creek, Cattarangus Co., N. Y., and the other from Bear Creek, Iowa, in which I have been able to confirm what he has stated. He also notices a third locality, viz. the Calumet Creek, sixteen miles south of Chicago, adding that "all these have the biserial arrangement of the birotules in the outer coat of the statoblast."

Of what *specific* value the bi- and triserial rows of birotulates may be I am not prepared to say, as I find them also in the statoblasts of *Meyenia fluviatilis* of Bombay, wherein the crust of those that are fully developed is very thick, and often shows *three* birotulates *end to end*, although not so numerous, so regular, or so uniform in arrangement as in the *innermost* row ; indeed I should say the outer ones were scattered, particularly those of the *outermost* row—recalling very much to mind the enormously long birotulates of Mr. Potts's *Heteromeyenia angyrosperma* ('American Naturalist,' Dec. 1883, p. 1296, fig. 13, *e, f*), in which one set are very long indeed and the other comparatively short; thus the former project much beyond the latter on the statoblast, which renders its surface correspondingly irregular. Nor is the size *alone* of the cells of the parenchymatous structure of any use specifically, as I find from a variety of *Spongilla fragilis* just (12th January) received from Mr. Potts, in which there are all sizes mixed together like the bubbles in froth.

XI.—*A Reply to the Remarks of Prof. Duncan on a Paper entitled "Contributions to the Actinology of the Atlantic Ocean."* By G. Lindström.

In the 'Annals and Magazine of Natural History' for December 1883, Prof. Duncan has thought proper to criticise a paper of mine which was published in 1877. Prof. Duncan, who during the interval of seven years "felt no disposition" to "reply" to me, now finds it necessary not only to "reconsider" my paper, but to use language by no means consistent with the quiet tone that ought to prevail in scientific discussions.

Prof. Duncan seems to think* that I, convinced of my errors, especially through his writings, ought to have recanted my statements long ago, and admitted that they were erroneous. I have not done so—first, because I am not convinced that I am wrong to the extent Prof. Duncan supposes; secondly, because I could not admit facts solely upon the dictum even of Prof. Duncan himself; thirdly, because I have not had occasion to revert to this matter specially until now, when I am compelled by Prof. Duncan's uncalled-for attack, much against my will, to turn from more urgent occupations.

Premising that a great part of his criticism consists of a recapitulation of remarks already made by Pourtalès and Moseley, and with which zoophytologists have been long conversant, I shall now try to reply to the points put forward as Prof. Duncan's own animadversions.

Caryophyllia Pourtalesii, Duncan.—I was led to give this

* "I hoped that time would bring some remarks from him. . . . . These researches [of Duncan, Pourtalès, and Moseley] might have modified Prof. Lindström's views; but as they do not appear to have done so," &c. (Ann. & Mag. Nat. Hist. Dec. 1883, pp. 361, 362).

name to my specimens, which are in a fine state of preservation, on account of the description, and especially the fig. 10, pl. xlii., in Prof. Duncan's first 'Porcupine' memoir. Though not quite so clear as might be desirable, this figure is far more instructive than those given later; and I may ask any one who chooses to compare my figure in 'Actinol. Atl. Ocean,' pl. i. fig. 4, with that above mentioned, whether I was not justified in referring the North-Atlantic coral to this species. As to the pali, Prof. Duncan seems himself to admit their partial deficiency. After speaking (Ann. & Mag. Nat. Hist. Dec. 1883, p. 362) of "the irregular pali," he says, "they are especially visible when the columella is small." This seems to imply that the columella varies in size, and that when the columella is large the pali are not so visible. But I cannot make out whether this means that they are deficient or that they are hidden from view. The former is probably the case, as it is stated in Duncan's second 'Porcupine' memoir, p. 238, that "the pali . . . . are well developed when the columella has only one twist, and are less so when this structure is more complicated." The accompanying figures 4 and 7 on pl. xliii. do not show any distinct pali. Moreover it may be questioned whether what have been called pali in several of the *Caryophylliæ* and others are really structures corresponding to the first definition given by Milne-Edwards in Ann. d. Sciences Nat. 1848, vol. ix. p. 80. If we take for granted that they are to be found "*entre* les cloisons et la columelle" and independent of either, as is shown in pl. iv. fig. 1 (*Caryophyllia cyathus*) of Milne-Edwards's memoir, those occurring in *Caryophyllia Smithii* are not pali, as they are in direct continuation of the septal lamina and formed by a deep vertical incision near the interior border of the latter, being in fact nothing but the innermost part of the septa*. It may be that such false pali occur now and then in specimens of *Caryophyllia Pourtalesii*; and one of my specimens shows an irregular indentation at the interior end of only one septum. Now, if *Caryophyllia cyathus* is provided with real pali, and other species, such as *C. Smithii* and *C. Pourtalesii*, have only false pali, I think this is a sufficient reason for separating them into different genera. I have never regarded *C. Pourtalesii* as a doubtful species, but I have only questioned the pro-

* Unfortunately Milne-Edwards, in the continuation of his description, also unites with the independent structures, which alone are true pali, those lobes or "dentelures" which so often occur on the axial end of the septa and are an integral part of them. But in reality a distinction must be made between the two.

priety of placing it in the genus *Caryophyllia*; and Prof. Duncan himself seems also now to be vacillating on this point, as he (Ann. & Mag. Nat. Hist. Dec. 1883, p. 363) says that it is a member of the *Caryophyllia* "*group*" which of course is something different from the "*genus*" *Caryophyllia*.

Paracyathus thulensis I did not implicitly propose as a synonym, but with a doubt, as plainly shown by the mark of interrogation. I admit, however, that it might have been better not to have mentioned it at all.

Leptocyathus Stimpsoni, Pourtalès.—There cannot be the slightest doubt that my specimens are identical with those of Pourtalès, who kindly sent me typical specimens for comparison. I have mentioned this in my paper. Moreover, Pourtalès, in the 'Blake' Report for 1878, p. 201, confirms my determination, and says, "In the Florida Straits . . . . . quite a number were dredged of the more elongated shape, which Mr. Lindström has found to be the prevalent form in the Eastern Atlantic." I then failed, and I still fail, to detect any pali, or any thing at all deserving that name, in them; and Pourtalès also says that those of a higher order are not very distinguishable from columellar processes. He, moreover, admits that the pali may be wanting in *smaller* specimens, when he says that he found them "quite distinct in *large* specimens in front of the tertiaries." It seems, then, that if pali exist at all they are highly variable, and occur in some specimens, while they are deficient in others. Nor are the pali at all clearly indicated in the figure given by Pourtalès in 'Deep-sea Corals,' pl. iii. fig. 2.

Leptocyathus? halianthus, Lindström.—Prof. Duncan says that either the description or the figure is wrong, as they contradict each other. Both are correct, though I admit that the former might have been more complete, and that there might have been one figure more. The case stands as follows:—There are in the Swedish State Museum two specimens dredged up alive, during the expedition of H. Swed. M. ship 'Eugenie,' off Cape Frio, both broadly attached to the valves of a *Pecten*. One of them is the original of the figure 9 of pl. i. in my paper, and there only the tertiary septa coalesce with the secondary ones. But in the other specimen those of the fourth and the fifth orders are united to those of the third in one moiety of the coral, while in the opposite moiety they are straight and do not coalesce at all. This, taken together with the former specimen, shows what a highly variable character this coalescence of the septa is. There are no pali. The costæ are large and prominent where they are not covered by a thin epitheca. It is true that the coral approaches very nearly to what I regarded as a variety of *Deltocyathus Agassizii*, pl. ii. fig. 16.

Deltocyathus Agassizii, Pourt.—Seeing the many different forms which have been lately grouped under this species, and comparing the figures of Milne-Edwards as well as original specimens from Monte Gibbio of *D. italicus*, I find that it is by no means finally settled whether *D. Agassizii* is to be merged into *D. italicus* or not.

I think Prof. Duncan makes too much of my having dared to hint at the possibility that his *Sabinotrochus apertus* might be a variety of *D. Agassizii*. "We do not want conjectures," he exclaims; and yet everybody who has consulted his writings must have noticed how freely he indulges in conjectures himself. Thus, for instance, Pourtalès remonstrates (Bull. Mus. Cambr. vol. vi. no. 4, p. 110):—"Prof. Duncan's supposition that the office of the pali is to support an extra circle of tentacles is not borne out in this species, nor in any other paliferous coral of which I have had the opportunity of examining the polyp." Further on Professor Duncan says, "Certainly the costæ and pali of *Trochocyathus Rawsoni* remove it entirely from *Deltocyathus*. . . . After seeing Lindström's criticism Pourtalès still retained the form in the genus *Trochocyathus*;" but Prof. Duncan omits quoting the following statement of Pourtalès (Bull. vol. v. no. 9, p. 199):—"There is no possibility of identity of this species with *D. Agassizii*, as supposed by Lindström, *though there is very little doubt that the two genera can scarcely be kept separate.*" In fact the numerous small, discoid, *Fungia*-like corals yet await a final arrangement by somebody who shall have access to all species described and to large numbers of specimens. This is evident when we see such zoophytologists as Pourtalès and Duncan give such conflicting opinions.

Flabellum laciniatum, Philippi.—Considering the many different forms of *Deltocyathus* which have been comprised under one and the same species, I find it less unreasonable to unite such forms as *Flabellum alabastrum* and *F. laciniatum*. My specimen, dredged up from 200–300 fathoms off the Azores, from its deeper coloration and the nearly straight edges of the septa, may be regarded as a variety of the North-Atlantic species. Prof. Moseley also says, "I cannot, however, tell what amount of variation a long series of specimens might show."

Schizocyathus fissilis, Pourt.—On comparing the figures given by Pourtalès and myself, there can be little doubt that we have described the same species. The presumed discrepancies may be reconciled in the following manner. We have given different values to the septal orders, viz. :—

The *primary* septa of Pourtalès are my				*tertiary* septa.	
The *secondary*	„	„	„	*primary*	„
The *tertiary*	„	„	„	*secondary*	„

Those large septa which are enclosed by a pair of other septa I regarded as the primaries. I was led to this by what I had learnt from *Balanophyllia Goësii* (Actin. Atl. Ocean, pl. iii. figs. 40–42), in which it is evident that the primaries are enclosed within two of the next succeeding order, that is the secondary, so that there are two secondaries for each of the primaries, or in all twelve, as seen on plate iii. fig. 41, in Actin. Atl. Ocean. On comparing smaller and larger specimens of *Schizocyathus* I cannot but think that I was right in arranging the septa as I had done. The primaries of Pourtalès are easily recognizable by their position inside the distinct line which is so clearly visible on the wall outside, and along which the coral splits. Now in the smallest specimens, scarcely 1 millimetre in length, what I have called primaries are the largest septa developed, and the primaries of Pourtalès, my tertiaries, are just beginning to appear.

Prof. Duncan further says (p. 367), "that there are no septa in Lindström's figure (pl. ii. fig. 27) in the position of the primaries of Pourtalès." It is true that they are not visible in the specimen figured, because their growth has ceased or is retarded, as is shown on the same plate (fig. 26). But I have other specimens, in which these septa, though short, are as plainly seen on a level with the others in the calicle as in the original specimen of Pourtalès.

As to my remark on the composition of the septum of three distinct strata or laminæ, one central enclosed within two lateral ones, Prof. Duncan makes a quasi-quotation from my paper, from which it might be implied that I have contradicted myself or partially admitted the truth of the old opinion. After briefly stating my views he adds that, "He [Lindström] *candidly admits* that the two laminæ are to be seen in some fossils" (Ann. & Mag. Nat. Hist. Dec. 1883, p. 367). I said, consistently with my view of there being three structural elements in the septum, that old and weathered specimens *look* just as if they had septa consisting only of two laminæ; but this is only owing to the central or original lamina having been removed by solution and its place left empty (Actin. Atl. Ocean, p. 17). It is just this structure of the septum which is one of the chief points that link the

Recent and Mesozoic corals with the Palæozoic forms, in which the same structure is often retained and easily enough distinguished.

Stenocyathus vermiformis, Pourtalès.—Prof. Duncan contends "that it is hardly conceivable that they [Pourtalès and Lindström] are treating of the same species." I have now, when I write this, and had also when I described the species, three specimens of *S. vermiformis*, sent from Pourtalès himself, named in his own handwriting *Cœnocyathus? vermiformis*, which was the first denomination given to the species. I cannot but see, even now on renewed examination, that his specimens and mine belong to the same species. Prof. Duncan, who must have seen so many specimens of living and fossil corals, ought certainly to be aware of their great variability—how some specimens take the shape of a regular cone, while others of the same species are crooked and vermiform; and consequently he ought not to be so much astonished, as he seems to have been, that I have placed turbinate and vermiform corals together. It is indeed more easy to reconcile my specimens with those of Pourtalès and with the fig. 12, pl. iii., in his 'Deep-sea Corals,' than to identify the figures 1 and 2, pl. i., in the same memoir with those given on pl. iii. figs. 11 and 12. Judging from these it really seems as if there had been two different species, one of which tallies with those described by me and with the specimens sent from Pourtalès. The latter author, in 'Deep-sea Corals,' p. 92, explanation of figures, says also that the calicle of fig. 12, pl. iii., is more common than that of pl. i. fig. 2. Moreover, I have now made a section near the wall of one of the specimens sent by Pourtalès, and it does not in any way differ from fig. 9, p. 20, in my paper. It depends, of course, much on the state of preservation of the coral whether this dissepimental trellis-work is left or not, as in the lower and older parts of the coral, where it may have disappeared through solution or other changes.

At present my time and the materials at hand do not admit of my entering further into the questions raised by Prof. Duncan's criticism, or attempting to settle finally some of the moot points, which would require more figures and more research than I can now bestow upon them. I have only defended my statements and views against him, and now leave to the unbiassed reader to decide on which side the "very hasty criticism" lies.

XII.—*On the Species of* Pseudoboletia. By Prof. F. Jeffrey Bell, M.A.

M. de Loriol has just added another to the many services he has rendered to the students of Echinoderms by the publication of the first part of a "Catalogue raisonné des Echinodermes recueillis par M. V. de Robillard à l'île Maurice" *, in which the Echinoidea are discussed. Among the forms found was the species of *Pseudoboletia* long since described by Michelin as *Toxopneustes indianus*; of this a full and elaborate description is opportunely given, and the concluding paragraph of discussion ends with the sentence—"M. Bell (*loc. cit.*) a pris, je crois, le *Pseud. indiana* pour le *Ps. granulata* et vice versâ; le *Ps. granulata* n'a jamais encore été envoyé de Maurice, à ma connaissance du moins."

It is perfectly true that M. de Loriol's description of *P. indiana* applies to specimens which have been labelled by me *P. granulata*.

The first question which arises, on this matter of fact being settled, is what kind of proof can one or the other adduce in favour of the view which he holds; as M. de Loriol says he has a specimen from Réunion which "correspond très exactement à la description de l'individu type de Michelin, qui provient également de la Réunion, et il est identique aux exemplaires de Maurice," it is clear that M. de Loriol is right, and that I am wrong.

I should not trouble the readers of this Journal with a demonstration of M. de Loriol's exactness (which has been proved by works too numerous to stand in need of any testimonial from me), or have thought it necessary to expose in such detail the steps by which I convinced myself of having been in error, were it not that, on examination of the whole question, I found that the more important matters on which I have now to enter could be best introduced in the manner here adopted.

There can be no manner of doubt that there are two species now in existence which belong to the genus *Pseudoboletia*; one of these is exactly known from the description and figures just published by M. de Loriol—*P. indiana*. Of this species specimens were presented to the British Museum in 1842, by Lady Frances Cole; and forty years later a specimen, covered with spines, was purchased by the Trustees from M. de Robillard; these specimens have been hitherto

* Mém. Soc. Phys. Hist. Nat. Genève, xxviii. no. 8.

labelled "*P. granulata*," but this shall be changed to *P. indiana.*

The other species was first described by Mr. Alexander Agassiz in 1863 as *Boletia granulata*, and was thus defined:—"Remarkable for its comparatively long spines. Tubercles uniform in size, very closely crowded together. Sandwich Islands." Ten years later a rather more detailed description was published in the 'Revision of the Echini' (p. 455), which agrees very well with the specimens which, in the British Museum, have been hitherto labelled *P. granulata*, save that I should not say of them that "the test is depressed, quite flattened both above and below, slightly conical, regularly arched in profile," as Mr. Agassiz's type specimens from the Sandwich Islands appear to be. As the description given by the author of the species *Boletia granulata* corresponds, so far as it goes, with that given by M. de Loriol of *Toxopneustes* (*Pseudoboletia*) *indiana* of Michelin, *granulata* and *indiana* would appear to be synonymous specific terms.

To come to the second species: that there is such a second species the collection of the British Museum is sufficient to bear witness, and we have specimens which go some way towards indicating the area of its distribution, from the Philippines and from Torres Straits. With regard to this species there should be less chance of error than with the other: firstly, because the student will not here be dependent on the poor services of one who still has much to learn *, but will have a specimen named for him by one whose services were solicited by a great nation containing not a few competent zoologists, and who, as is well known, is the greatest living authority on the Echinoidea—well, the specimen named by Mr. Agassiz for the 'Challenger' collection is called *P. indiana*; secondly, this species is not one that can be easily mistaken, on account of the curious dark brown patches on its test and on its spines. The species with patches is identical with the *P. indiana* from the 'Challenger,' and the description given in the 'Revision' of *P. indiana* applies to the specimens so labelled by me in the British Museum.

I have, I trust, made it clear that, in the absence of Michelin's or of Agassiz's type specimens of the two species, I had (*a*) the next best thing—a specimen named by Mr. Agassiz, the namer of one of the two recognized species; (*β*) that I had only the incomplete definitions of Michelin or Agassiz, in addition to the information given in the 'Revision' itself; or, in other words, I was, I submit, justified in taking the 'Revision' as my guide.

* *Cf.* P. Z. S. 1880, p. 36.

The only possible fault then that can, here at any rate, be found with me (and I am sure no one will call it a fault) is that I put my trust in Mr. Agassiz's 'Revision of the Echini.' To him therefore what blame is due must be transferred.

Two questions now remain: the first is, what name shall be given to the species which has been till now labelled in the British Museum *P. indiana*? In the year 1869 that eminent zoologist the late Professor Troschel described in the 'Sitzungsberichte' (not 'Verhandl.,' as stated by Mr. Agassiz, *op. cit.* p. 153) two species of *Pseudoboletia*—*P. stenostoma* and *P. maculata*: the former appears to be a synonym of *P. indiana* (Mich.); the latter is in all probability the species which now is found to be without a name, but has been labelled *P. indiana*.

The "synonymy" of the species will then stand thus:—

Pseudoboletia indiana.

Toxopneustes indianus, Michelin, in Maillard's 'Réunion,' ed. 2, annex. A, p. 5.
Sphæriechinus indianus, Lütken, Bidrag, p. 76 (144).
Pseudoboletia stenostoma, Troschel, Sitzb. nat. Ver. preuss. Rheinl. 1869, p. 96.
Pseudoboletia granulata, Agassiz, Rev. Ech. pp. 153 and 455; Bell, P. Z. S. 1881, p. 432.
Pseudoboletia indiana, de Loriol, Cat. raisonné Ech. Maurice (1883), p. 28.

Pseudoboletia maculata.

Pseudoboletia maculata, Troschel, Sitzb. nat. Ver. preuss. Rheinl. p. 96.
Pseudoboletia indiana, Agassiz, Rev. Ech. p. 456, pl. v. *a*, figs. 8 and 9; Bell, P. Z. S. 1881, p. 433; Agassiz, Chall. Rep. Ech. p. 107.

The second question that remains for consideration is the geographical distribution of the species, in which again there is some confusion, owing to the statements made by Mr. Agassiz. In the Rev. Ech. p. 153, the only locality given for "*P. granulata*" is Sandwich Islands, while "*P. indiana*" is said to come from Masbate, Philippines, Mauritius, Bombay, and Bourbon. Specimens from the first three of these localities are said to be in the British Museum; it is now clear that those from the first two are examples of *P. maculata*. For *P. indiana* Mauritius and the neighbouring islands are authentic localities, while, like *Tripneustes variegatus*, it appears too to be found at no less distant a locality than the Sandwich Islands. In conclusion it may be added that Mr. Agassiz incorrectly prefixed the sign ⊕ to his "*P. indiana*" of the 'Challenger' Report (p. 269), inasmuch as that sign means that the species was "previously known, but found in the district for the first time by the 'Challenger';" and, on his own showing, he had seen in the British Museum, some ten years previously, specimens from Masbate and the Philippine Islands.

The preceding remarks show into what confusion the species of this genus, with a literature more scanty than most, have been allowed to fall, and the thanks of systematic naturalists are due to M. de Loriol for directing attention to its condition.

XIII.—*On new* Stylasteridæ, *with Remarks on some recently described Forms.* By J. J. Quelch, B.Sc. Lond., Assistant, Zoological Department, British Museum.

The four species herein described as new are founded on specimens in the collection of the British Museum. Special interest is attached to *D. breviserialis*, owing to the very great obliteration of the lateral furrows of cyclosystems, except at the distal parts of the cœnosteum; and also to *Allopora ochracea*, in which the number of the dactylozooids in each cyclosystem is very limited, being usually only three or four. The locality of *Stylaster pulcher* is specially interesting among the Hydrocorallinæ. In describing the colours of the specimens I have had reference to Werner's 'Nomenclature of Colours.'

Allopora ochracea, n. sp.

Cœnosteum of a reddish-orange ochre colour, branched, compact, irregularly flabellate; branches thick, spreading, slightly flattened and obtuse at the ends; surface nearly smooth or finely granulated; cyclosystems closely placed on all parts, often in irregular series, being about ·5 millim. to 2 millim. apart, of very variable structure, but not raised above the general surface of the cœnosteum; dactylopores very few in each system, variable in number, from 1 to 5, generally 3 or 4, very rarely absent, small, subcircular, placed irregularly around the gastropore, with cavities always distinctly separated, and occupied by a relatively large hirsute style; gastropores about ·4 millim. in diameter, circular, rather deep, with a thick, rather short, hirsute style; ampullæ large, about 1½ millim. in diameter, vesicular.

Hab. Unrecorded. B.M.

The specimen to which this specific name has been given consists of a small broken portion of a rather massive structure—a short branch with four short chief branchlets, on different parts of which there are indications of still smaller branchlets. In the sum of its characters it differs altogether from all other known species, though in many points its close affinities with *A. californica*, V., *A. venusta*, V., *A. miniata*, Pourt., and *A. nobilis*, K., are clearly seen. Its thick and massive structure, its cyclosystems placed on all sides of its branches and not raised above the surface, its few dactylopores in each system (generally 3 or 4), its rather short thick style in the gastropore, and its reddish-orange ochre colour are its essential characters, and will serve to mark the species with certainty. As the specimen is simply a broken branch, the details of the *form* of the entire cœnosteum must await description from a more perfect specimen; but it is probable that it will be found to agree very closely with *A. nobilis*, K.

Stylaster pulcher, n. sp.

Cœnosteum of a yellowish vermilion or bright tile-red colour, much branched, somewhat flabelliform but very irregularly so, branches not coalescing, surface very finely marked with whitish striations, especially on the basal parts; main trunk and branches rather thick, rounded or very slightly compressed, regularly diminishing and giving off many short branchlets, but these are not very small or delicate; cyclosystems arranged in two rows on opposite sides of the branches, but this is often disturbed, and many are found scattered over the surface of the cœnosteum, very few towards the basal parts of the main trunk, many having given rise to branchlets, very variable in size and structure, subcircular or elongate, prominent but never pedicellate, about ·75 millim. in diameter, often much smaller, about 1·25 millim. apart in the same row; dactylopores generally about 8 to 10, frequently less, very rarely 11 or 12, small, with minute styles, often unequally placed around the gastropore so as to give a varying thickness to the pseudosepta; gastropores very deep, rather wide, with a distinct short brush-like style; ampullæ forming circular swellings, rather paler than the axis in colour, about 1 millim. in diameter, placed on all sides of the branchlets, and giving them a rough swollen appearance; many small pores, about the size of the dactylopores, occur scattered over the surface of the cœnosteum.

Hab. Enoshima Island, Japan. B.M. (presented by Dr. F. J. Burgė).

This species is closely related to *S. elegans*, V., *S. tenuis*, V., and less so to *S. obliquus*, Stud., but its differences are well marked and easily separate it. The larger of two specimens in the collection is about 5·5 centim. high, its base being about 6 millim. thick and its branchlets about 1·5 millim. thick close to their extremities. Many large swollen ampullæ occur on this specimen, being quite absent on the smaller. On this smaller specimen, however, there occur on the branchlets many small, raised, white porous masses, which are very rarely present on the larger specimen, and which, when scraped away, reveal circular cavities in the cœnosteum. These are markedly different from the large, coloured, non-porous ampullæ.

Distichopora breviserialis, n. sp.

Cœnosteum of a rather deep flesh-red or pale aurora-red colour, branched, very compact, irregularly flabellate, with the surface granulated, roughened, and minutely canaliculated; branches often coalescent, rather short, thick, uneven, often twisted, almost round above, but much compressed, at the base especially, where three or four branches arise together in the same plane; branchlets very short, thick, and obtuse, of a deeper colour than the rest of the cœnosteum; cyclosystems almost entirely absent from the main branches and the basal parts of the longer branchlets, primarily developed on opposite sides of the branched cœnosteum in well-marked furrows, as indicated on the extremities of the branchlets, but becoming obliterated by growth, except where incipient branchlets are present on the main stem and branches and at the extremities of the long branchlets; at these extremities the dactylopores, which are very small, are generally situated on raised lateral ridges on each side of the furrow, with many smaller pores on the face of the branchlets, but these gradually disappear by overgrowth; the gastropores are very irregularly shaped, large and small often alternating at a distance apart about equal to their diameter, with deep, long, and thin styles, finely plumose; large, swollen, distinct vesicular ampullæ are absent, but on many parts of the branches and branchlets occur rough masses of small irregular cells, often open, which seem to be ampullæ.

Hab. ——? B.M.

The specimen of this species consists of a cœnosteum about 7 centim. high, with six main branches, the thickness of which is about 7 millim. at base, being much wider in the plane of the flabellum. Many of the branchlets are broken off and others were dead when the specimen was taken. The species has many points of affinity with *D. rosea*, Kent, but differs strikingly in the structure and position of its cyclosystems and its colour, *D. rosea* being almost of a deep peach-blossom red, with well-marked furrows throughout the cœnosteum, although these are often irregularly interrupted, and with large elongated dactylopores. It seems probable that Tenison-Woods, who himself was doubtful of the identification, has mistaken this form for *D. rosea*, K., since the additional characters which he has given belong to this species and not to *D. rosea*.

Distichopora Milesii, n. sp.

Cœnosteum of a dull lake-red colour, branched, flabellate, compact, very slender, with an uneven granulated surface, irregularly canaliculated; branches very small, even at their base, rounded; branchlets short, small, obtuse, slightly compressed at the tips, and somewhat smaller than the branches; cyclosystems arranged evenly on opposite sides in very distinct, deep, continuous lateral furrows; dactylopores small, placed in a line on the edges of the furrows, very elongated in a direction at right angles to this line; gastropores often unequal, placed very close to each other, with but a narrow partition between them, having long, deep, thin, and finely hirsute styles; ampullæ in raised crowded masses in which cells are almost undistinguishable, giving a warty appearance to the cœnosteum.

British Museum: received in exchange from the Brighton Museum, through the kindness of Dr. Miles of Brighton, after whom, in acknowledgment, the species has been named.

Hab. South Sea Islands. The exact locality is unknown; but as the specimen was growing on the same piece of rock as a very fine *Stylaster stellulatus* (Stewart), a species which has hitherto been recorded only from the Society and Paumotu Islands, it is probable that it was obtained in this region.

The specimen of this species is about 3 centim. high, the branches and branchlets being about 2½ and 1½ millim. thick respectively. The only species to which it seems to be closely related is *D. fragilis*, Dana; but the description of this is so short, and its details so few, that its identification becomes somewhat uncertain. Judging, however, by the figures of *D. fragilis* in the 'Atlas,' which do not seem to me to represent one species, *D. Milesii* can be easily distinguished by its dull lake-red colour and its rounded branches. Although agreeing somewhat in colour with *D. coccinea*, Gray, yet its much more delicate and rounded form, and the structure of its cyclosystems separate it widely, even from small specimens of that species.

Distichopora livida, Tenison-Woods.

This species was first described by the Rev. J. E. Tenison-Woods, in the Proc. Linn. Soc. New South Wales, vol. iv. 1879; and in his valuable monograph of the genus (Journ. Roy. Soc. N. S. Wales, 1879) that author gives further details of its structure. It is to be regretted, however, that a more definite term than "livid" was not given in the description of the colour of the main portion of the cœnosteum, since this furnishes such a valuable help in the determination of the species. Judging by specimens in the British-Museum collection, which seem to belong to this species and of which the locality is unknown, the colour varies considerably from dull or pale purplish red to dull reddish or brownish orange, having the extremities, as given in the description of the species, white, yellow, or orange, and the lateral furrows and incipient branchlets bright red or orange. If this identification is correct, it will be seen how closely this species is related to, if indeed it is distinct from (which may fairly be doubted), *D. nitida*, Verrill, which comes from the same locality, and the description of which Tenison-Woods had had no opportunity of consulting. If, however, the strict meaning of *lividus* was intended, *i. e. bluish* or *black and blue*, then this species presents a most remarkable variation in colour, and certainly would seem to be distinct from any yet described; and although stated to be very common in collections made in the neighbourhood of the Solomon and Marshall Islands, it is absent from the large and very fine collection of Stylasteridæ in the British Museum.

Distichopora nitida, Verrill.

Distichopora nitida, Verrill.
Distichopora Brasseyi, Bryce Wright.
Distichopora Allnutti, Bryce Wright.

It seems advisable to state here, in order to prevent misunderstanding and further complication in the synonymy of the species, a few facts concerning the characters and distribution of *D. nitida*, V., which must have been known to any one who had read the description of the species.

The specimens of *D. nitida* described by Verrill in the Bull. Mus. Comp. Zool. vol. i. no. 3, published in 1864, were collected by A. Garrett, at *Ebon Island* (Marshall Islands), and although described in the old terminology before the brilliant researches of Prof. Moseley revealed the true nature of the Stylasteridæ, yet the *main* characters as given in the old description are sufficiently striking.

The following are selected from it:—"Corallum flabelliform, branching dichotomously in a plane; branches round or flattened transversely; branchlets obtuse, often compressed at the tips; surface very minutely granular, appearing almost smooth, with scattered patches of rounded verrucæ; three rows of minute pits arranged closely in regular series along the edges of the branches, those of the central larger row circular, often having a slender columella in the centre; lateral ones much smaller, generally irregular in form; colour bright red, tips of the branches yellowish white; other specimens are light orange."

From this it will be seen that even in the specimens described by Verrill the variations of colour were remarkable, ranging from bright red to light orange.

In the Ann. & Mag. Nat. Hist. 5th ser. vol. ix. (1882), p. 74, in a paper "On some new Species of Corals," in which this species was redescribed as *D. Brasseyi* and *D. Allnutti*, it is stated that the *habitat* of *D. nitida*, with the many species described by Pourtalès, is the *Gulf-stream and in and about the West-India Islands and Florida*; while its colour is indicated as being of a *whitish* tint, and is contrasted with the vivid colours of the Pacific species, from the list of which *D. fragilis*, D., and *D. livida*, Tenison-Woods, are omitted!

It is scarcely to be wondered at that, having so little knowledge of the characters and distribution of the species, the author of this paper should have redescribed it under two new specific terms.

Where the colour in the same species, and more especially in the same specimen, varies so extremely, it is confessedly a difficult matter to name the combination in such a way as to convey exactly to another what is intended; but the specimens of *D. nitida* which have so lately been described as *D. Brasseyi* and *D. Allnutti* seem to present unusual difficulty; for in one place they are given as being "of a fuscous or deep foxy-red orange and of a pinkish orange respectively," while in another they are "fuscous orange-red in colour, paling towards the extremities," and "deep red, tinted or slightly mottled with orange at the extremities of the stems and adult branches, paling off into white and pale orange-yellow."

The specimens collected by Lady Brassey were from the Gilbert Islands, a group in the immediate vicinity, and south of Ebon Island; and though they certainly are unique and most interesting in point of size, no sufficient character has yet been given which would separate them into different species. Indeed the very characters most insisted upon are those which seem most certainly to point to their identity with *D. nitida*, Verrill.

Distichopora coccinea, Gray.

In his monograph of the genus, the Rev. J. E. Tenison-Woods has given a figure of this species, and states that he does not think the species has yet been figured. It may be pointed out that when the species was described by Dr. Gray it was also figured (Proc. Zool. Soc. 1860).

XIV.—*Contributions to Micro-Palæontology.—Notes on some Species of Monticuliporoid Corals from the Upper Silurian Rocks of Britain.* By H. ALLEYNE NICHOLSON, M.D., D.Sc., Regius Professor of Natural History in the University of Aberdeen.

[Plate VII.]

It has long been my intention to give a detailed account of the microscopic structure of the Monticuliporoid Corals of the Wenlock Limestone of Britain, so far as known to me. I have found, however, that the accomplishment of this would demand more time than is at present at my disposal; and I therefore, in the meanwhile, publish the following notes on the minute structure of some of the commoner Wenlock Monticuliporoids*, in the hope that they may prove useful to other workers in the same field. From the brief descriptions and accompanying figures of structure, it will, I think, be found easy to recognize the types which I have had under observation, and this is the special object which I have had in view. On the other hand, I have found great difficulties as to the nomenclature of the forms here described, and I have not been able to clear up these difficulties to any extent. The earlier observers of these fossils, as, for example, Mr. Lonsdale, necessarily founded their names upon macroscopic cha-

* Besides certain ramose Monticuliporoids which I have as yet imperfectly examined, the Wenlock Limestone contains various incrusting forms (such, for example, as the curious type figured by Milne-Edwards and Haime under the name of *Monticulipora papillata*), which require for their elucidation a more detailed investigation than I have hitherto been able to undertake.

racters principally, the method of investigation by means of thin sections being of recent origin; and they also gave, as a rule, extremely brief descriptions. Hence it is exceedingly difficult, in many cases, among the Monticuliporoids, to be certain as to the precise forms to which the older names should be attached. In the following notes, therefore, I have not employed any of the older specific names, except in cases where I can do so with tolerable certainty of being correct in so doing. Those forms which I cannot satisfactorily identify with previously described species I have provisionally designated by new titles, though it is quite possible that some of these will also prove to be referable to species to which names have been attached at some earlier date.

1. *Fistulipora crassa*, Lonsd. sp. (Pl. VII. figs. 1, 1 *a*, 2, 2*a*.)

Heteropora crassa, Lonsdale, Sil. Syst. pl. xv. figs. 14, 14 *a* (1839).

The corallum in this species is ramose, the branches being rounded or somewhat compressed, mostly solid, and varying in diameter from about one line up to half an inch. The surface appears to be smooth, and devoid of either monticules or maculæ, so far as I have seen. The tube-mouths are usually distinctly, though slightly, elevated above the general surface, and are surrounded by a distinct ring, though in some exceedingly well-preserved specimens these features are not observable. The interstitial tubules may or may not be superficially recognizable. In thin tangential sections (Pl. VII. figs. 1 & 2) the corallites are seen to be oval or circular, not markedly pinched in or indented at any point, and varying in size in different specimens, being mostly between $\frac{1}{100}$ and $\frac{1}{80}$ inch in diameter (generally nearer the latter). In one section I have examined (fig. 2) two of the corallites are seen to be connected by a lateral tube of communication. The interspaces between the corallites are rarely more than $\frac{1}{120}$ inch in diameter, and they are occupied by interstitial tubuli, which are polygonal or angular in shape, with imperfect walls. Mostly only a single row of such tubuli separates any pair of contiguous corallites, but two rows are also often seen in places. In long sections (Pl. VII. figs. 1 *a* and 2 *a*) the corallites are seen to be crossed by a few complete and approximately horizontal tabulæ; while the interspaces between them are occupied by vesicular tissue formed by the anastomosis of the tabulæ of the interstitial tubules. No "spiniform corallites" appear to be present.

It is, perhaps, open to question whether Lonsdale's figure and description of *Heteropora crassa* really apply to this form, and not rather to the very similar *F. ludensis*, which I shall describe immediately.

If, however, Lonsdale's title is to be retained, it is best to keep it for the form which has been usually regarded by observers as *Heteropora crassa*. There is no doubt as to the propriety of the reference of this form to *Fistulipora*, M'Coy, as shown by the in general complete isolation of the corallites, and the fact that the walls of the interstitial tubules are so imperfect as to allow of a confluence of their tabulæ, and the consequent production of an intermediate vesicular tissue.

Fistulipora crassa is most nearly allied to *F. ludensis*, Nich., from which it is distinguished by its not forming thin crusts, by the generally projecting mouths of the corallites and their larger size, by the larger size and smaller number of the interstitial tubuli, as well as by their incomplete walls, and, lastly, by the want of "spiniform tubuli."

Formation and Locality. Wenlock Limestone, Dudley, Benthall Edge, Dormington.

2. *Fistulipora ludensis*, Nich. (Pl. VII. figs. 3–3 *b*.)

The corallum in this species forms thin crusts, from half a line to three quarters of a line in thickness, growing upon foreign objects. The surface is smooth, without definite maculæ or monticules, and exhibits the circular openings of the ordinary corallites, surrounded by very numerous minute interstitial pores. As seen in tangential sections (Pl. VII. fig. 3), the corallites are seen to be circular or oval, often indented at one point, or at two points, and about $\frac{1}{100}$ inch in diameter. The corallites are in general completely isolated, and are separated by one, two, or three rows of very minute interstitial tubuli, which are subpolygonal in shape, and have tolerably complete walls. As just mentioned, the wall of the visceral chambers of the corallites is often bent inwards on one side or at more than one point, and at such points "spiniform tubuli" are usually developed (Pl. VII. fig. 3 *a*). Similar spiniform tubuli may also be sparingly developed among the ordinary interstitial tubuli. As seen in long sections (Pl. VII. fig. 3 *b*), the corallum is seen to be built up of successively superimposed thin strata of tubes. The proper corallites are crossed by a few remote, complete, horizontal tabulæ; while the interstitial tubules have more closely set tabulæ, which are so disposed as to give rise in the longitudinal section to a sort of vesicular interstitial tissue.

The present species is in many respects very similar to *Fistulipora crassa*, Lonsd., sp.; and it is quite possible that Mr. Lonsdale may have had this form, at any rate partly, in view in describing his *Heteropora crassa.* As regards its general characters, it is distinguished from *F. crassa* by its habit of growth, and also by the much greater development of the interstitial tubuli, which give to the surface of well-preserved specimens a minutely porous appearance. Moreover, the mouths of the corallites are not surrounded by prominent rims. As regards internal structure, the chief features which distinguish *F. ludensis* from *F. crassa* are the greater number of the interstitial tubes and their more complete walls, the smaller size of the ordinary corallites and their more complete isolation, and the presence of well-marked "spiniform tubuli."

Formation and Locality. Wenlock Limestone, Dudley. The best preserved specimen I have seen forms a thin crust growing upon a specimen of *Monticulipora pulchella*, E. & H., which it entirely envelops.

3. *Callopora nana*, Nich. (Pl. VII. figs. 4–4 *b*.)

The corallum in this species is in the form of minute, cylindrical, or bulbous masses, generally two or three lines in length, and about a line or a line and a half in diameter. The surface is free from monticules or maculæ, but exhibits the openings of the large circular or oval corallites, largely or wholly separated by irregular, often oblong interstitial pores. In tangential sections (Pl. VII. fig. 4 *a*) the corallites are seen to be oval or subcircular, averaging about $\frac{1}{50}$ inch in their long diameter, which corresponds in direction with the long axis of the corallum. They are separated by intervals occupied by the interstitial tubes, which have quite complete walls, and are mostly long-oval or irregularly oblong in shape. The long diameters of the interstitial tubes correspond with the long axis of the corallum, and vary from $\frac{1}{100}$ inch to $\frac{1}{60}$ inch, their shorter diameters being from $\frac{1}{125}$ to $\frac{1}{150}$ inch. Hence the intervals separating contiguous corallites are much greater in the direction of the long axis of the coral than when measured transversely to the corallum.

In long sections (Pl. VII. fig. 4 *b*) the corallum is seen to be composed of tubes which are vertical in the axis of the colony, and then gradually bend outwards to open on the surface. They are similar in internal structure throughout their entire extent, complete horizontal tabulæ being largely developed both in the axial region and the peripheral region, while their walls have a nearly uniform thickness throughout. As they bend outwards, however, towards the surface, the corallites become separated by the development of the interstitial tubes, which entirely resemble the proper corallites in structure, except in the fact that they possess a much larger number of tabulæ, these structures, however, being still horizontal and complete, and not assuming a vesicular character.

As regards the generic position of this species, I find it necessary to make a few remarks, as I have elsewhere (Pal. Tab. Cor. p. 304) expressed the opinion that *Callopora*, Hall, should be regarded as a synonym of *Fistulipora*, M'Coy. I arrived at this view from a study of the description and figures given by Prof. Hall of *Callopora*, from an examination of M'Coy's type species of *Fistulipora*, and from an investigation of various corals which appeared to be precisely similar to various forms included by Prof. Hall under *Callopora*. That *Callopora*, Hall, has been made by its original founder, as well as by other palæontologists, to include a large number of heterogeneous forms, and that some of these are truly referable to *Fistulipora*, M'Coy, are points which appear to me to be free from doubt, and it was therefore not unnatural that I should have concluded that the two genera were identical.

Recently, however, this question has been attacked in a more satisfactory manner by Mr. Ulrich (Journ. Cincinn. Soc. Nat. Hist. 1882), who has had the opportunity of examining by means of thin sections authentic specimens of *Callopora elegantula*, Hall, which is the type species of the genus *Callopora*, Hall. Mr. Ulrich has shown that this species differs in its structure from the majority of the numerous forms referred by Prof. Hall to *Callopora*, and that it exhibits characters entirely similar to those of various Monticuliporoids which I included under the name of *Heterotrypa*, and certainly quite unlike those of *Fistulipora*, M'Coy. While I am not prepared to admit the justice of all the remarks which Mr. Ulrich has seen fit to make upon this subject, I am quite ready to recognize the new light which he has thus thrown upon the structure and affinities of *Callopora*, Hall. I also quite recognize that *Heterotrypa*, as originally defined by me, is a wide group which may be advantageously subdivided. For these reasons, therefore, I shall accept the genus *Callopora*, Hall, as defined by Mr. Ulrich, as including Monticuliporoids of the type of the present species, with numerous interstitial tubes, which resemble the normal corallites in all except their size and their possession of more numerous tabulæ. The corallites, moreover, are always rounded, and their walls are amalgamated.

The nearest allies of *Callopora nana*, so far as I know at present, are *C.* (*Heterotrypa*) *O'Nealli*, James, and *C.* (*Heterotrypa*) *nodulata*, Nich., both of which are found in the Cincinnati group of North America. From both of these forms, however, the present species is distinguished by well-marked external and internal peculiarities, its distinguishing features being its small dimensions, the proportionately large size of the corallites, and the peculiar elongated form of the interstitial tubes, while a marked internal feature is the very extensive development of the tabulæ in not only the peripheral but also the axial region of the corallites.

Formation and Locality. Wenlock Limestone, Benthall Edge; Wenlock Shales, Buildwas.

4. *Callopora Fletcheri*, E. & H. (Pl. VII. figs. 5–5 *b*.)

Monticulipora Fletcheri, Edwards & Haime, Brit. Foss. Corals, p. 267, pl. lxii. figs. 3, 3 *a*.

Corallum ramose, of cylindrical branches, which have a diameter of from a line and a half to two lines and a half. There are no proper monticules or maculæ; but the surface shows the approximately circular apertures of the ordinary corallites, the diameter of which is about $\frac{1}{60}$ inch. The corallites are separated by interspaces of from $\frac{1}{250}$ to $\frac{1}{125}$ inch in diameter, and in badly-preserved specimens these interspaces either appear as solid or show only here and there a minute polygonal opening. On the other hand, in well-preserved examples the intervals between the ordinary corallites are seen to be wholly occupied by the openings of interstitial tubuli. In tangential sections (Pl. VII. fig. 5 *a*) the corallites are seen to be thick-walled and circular, with a well-defined internal boundary, though not showing the peculiar dark marginal ring which is so characteristic of many species of *Callopora.* Occasionally minute tooth-like processes, which look like septa, project into the visceral chamber, though I have never seen more than two or three of these in a single corallite. The walls of the corallites are amalgamated with those of the interstitial tubes, and there is rarely more than a single row of the latter, while in places the corallites are actually in contact. The interstitial tubes are rounded or polygonal, and only rarely have an elongated form. In long sections (Pl. VII. fig. 5 *b*) the ordinary corallites are seen to be provided abundantly with complete horizontal tabulæ, both in the axial and the peripheral region of the corallum. As they proceed outwards from the centre to the circumference of the branches, they bend at a considerable angle, and their walls become at the same time considerably thickened. The interstitial tubules altogether resemble the normal corallites in structure, except that they are provided with much more numerous tabulæ. Moreover, in old examples the interstitial tubules become largely filled up with secondary deposit, so that their cavities become largely or wholly obliterated.

I feel very doubtful as to whether or not I am correct in identifying the present species with the *Monticulipora Fletcheri* of Edwards and Haime. After an examination, however, of a very large number of specimens I have come to the conclusion that these observers probably founded the above-mentioned species upon an example of the form which I have just described, in which the surface was not sufficiently well preserved to show more than a few of the larger interstitial tubes. At any rate, if this conclusion be incorrect, I know of no other similarly shaped and sized coral in the Wenlock Limestone which would show the same circular calices separated by well-marked interspaces.

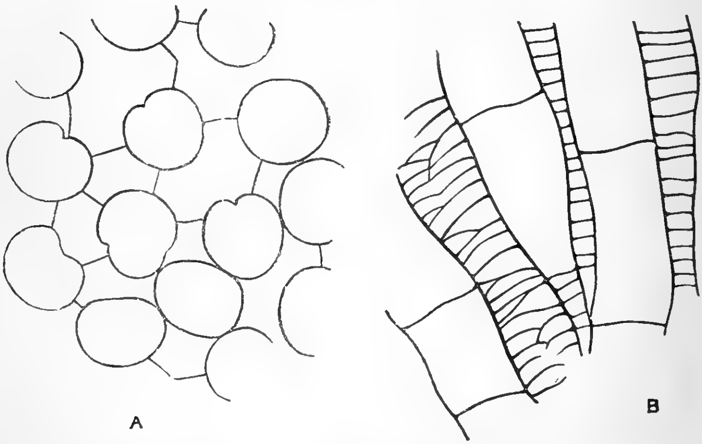
In various structural features *Callopora Fletcheri* shows a resemblance to *C. nana*, Nich.; but it is distinguished by its generally much larger dimensions, the circular shape and thick walls of the corallites, and the polygonal form and small size of the interstitial tubules. Internally the present species is at once distinguished by the thickening of the walls of the tubes, which in old specimens is sometimes carried so far as to almost entirely fill up and obliterate the interstitial tubes.

Formation and Locality. Not uncommon in the Wenlock Limestone of Benthall Edge and Dormington.

5. *Callopora? glans*, Nich. (Fig. 1 and Pl. VII. fig. 6.)

The corallum in this species is of small size, generally about four or five lines in greatest height and width, and mostly subspherical, hemispherical, or pyriform in shape. Sometimes a basal epitheca is developed; but at other times the corallum is apparently destitute of this structure, its under surface, except the peduncle of attachment, being covered by the calices. The surface shows no monticules or maculæ, and is covered with the large circular openings of the corallites, with the well-marked apertures of the minute interstitial tubes between them. As seen in tangential sections (fig. 1, A) the corallites are provided with very thin and delicate walls, and have a diameter of about $\frac{1}{50}$ inch. They are approximately circular, but their wall is generally bent inwards at one or more points into a kind of pseudo-septal fold, giving the visceral chamber a heart-shaped form. In other cases there are two of these infoldings of the wall, generally placed opposite each other. The corallites often touch at points, but they are mostly separated by narrow interspaces occupied by a single row of large, angular, imperfectly walled interstitial tubes. As seen in long sections (fig. 1, B) the ordinary corallites are crossed by a few remote and complete tabulæ, and the interstitial tubes are provided with numerous horizontal tabulæ, which at times anastomose and become subvesicular.

Fig. 1.



Callopora ? glans, Nich. A, tangential section, enlarged twenty times; B, longitudinal section, similarly enlarged.

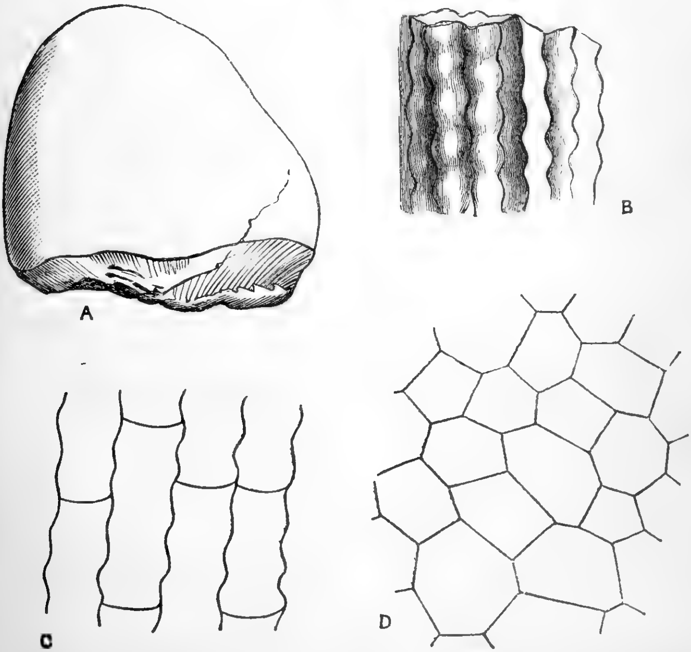
I am indebted for specimens of this curious species to the kindness of Mr. Madeley, of Dudley. It is of interest as forming in some respects a transition between the proper *Fistuliporæ* and the typical species of *Callopora*. This is shown both in the infolding of the walls of the corallites, which is such a characteristic feature of the species, and also in the fact that the walls of the interstitial tubes are so imperfect as commonly to allow of a confluence of their tabulæ, giving rise to a partially vesicular interstitial tissue. *Callopora? glans* has some resemblances to one of the numerous Russian Monticuliporoids which have the general form of *Monticulipora petropolitana*; but I know of no form with which it could be confounded.

Formation and Locality. Lower Ludlow shales, Sedgeley.

6. *Monotrypa crenulata*, Nich. (Fig. 2.)

The corallum in this species is hemispherical or subglobular, ordinary examples having a height of an inch or an inch and a half, and a diameter of about the same at the base. The base is flat or concave, and is covered by a striated epitheca; and the corallites radiate from the base to open over the whole convex upper surface of the colony. The corallites are prismatic, mostly pentagonal, thin-walled, and not firmly united with one another, their walls being regularly and uniformly crenulated in such a manner that contiguous tubes are accurately dovetailed together. The corallites vary in size from about $\frac{1}{50}$ inch up to $\frac{1}{35}$ inch, there being occasionally definitely defined groups of the larger tubes. No spiniform tubuli are developed. The surface is apparently smooth and devoid of

Fig. 2.



Monotrypa crenulata, Nich. A, outline of a specimen, of the natural size; B, part of a few tubes, enlarged; C, longitudinal section, enlarged twenty times; D, tangential section, similarly enlarged.

monticules. As seen in long sections the tubes are found to be crossed at considerable intervals ($\frac{1}{25}$ to $\frac{1}{10}$ inch) by a few horizontal tabulæ, which are not uniformly placed at corresponding levels in contiguous corallites.

I think it tolerably certain that this form corresponds with part of the *Favosites fibrosa* of Mr. Lonsdale (Sil. Syst. pl. xv. *bis*, figs. 6–6 *d*); and I should very willingly have retained the specific name of *fibrosa* if this had seemed at all advisable. The name of *Favosites fibrosa* has, however, been given by different authors to very different corals *, and the specific name can only be retained for the form to which Goldfuss originally applied this title, whatever that may really be. The widest differences also have existed among British palæontologists in their descriptions of the characters and structure of the forms to which this name has been given. Thus Mr. Lonsdale both figures and describes mural pores in some of the forms which he placed under *Favosites fibrosa*, whereas M'Coy expresses his conviction that mural pores are wanting, and places the forms which he considers Lonsdale to have had in view under *Stenopora*, retaining for them the specific name of Goldfuss. Again, it seems certain that Milne-Edwards and Haime, in their great work on the British Fossil Corals, included two quite distinct types, one from the Devonian and the other from the Silurian, under the name of *Favosites fibrosa*. Upon the whole, therefore, it has appeared to me to be safest to give a new name to the forms now under consideration, even though they should prove to be what Lonsdale regarded as *Favosites fibrosa*, Goldf.

As to the generic position of this type, I have failed to convince myself that it possesses mural pores. The shape of the tubes reminds one of what one sees in some species of *Favosites*, such as *F. aspera*, D'Orb., and *F. mullochensis*, Nich. and Eth., and one naturally expects to find foramina on the crenulated angles of the corallites. Moreover, I have occasionally seen phenomena which I should have regarded as probably indicating the presence of mural pores, had I been able to look only at rough fractures of the coral with a comparatively low magnifying-power. If mural pores really

* If we take the description of *Favosites fibrosa*, Goldf., given by Milne-Edwards & Haime (Pol. Foss. p. 244) we find at once that it cannot possibly be the same as the form here under consideration, since (quite apart from the question of the presence or absence of mural pores) the tabulæ are stated to be very close-set (five or six in the space of a millimetre). Similarly the close-set tabulæ, as well as the want of crenulated corallites, will show that the form figured by these same authors from the Devonian of Devonshire as *F. fibrosa*, Goldf. (Brit. Foss. Cor. pl. xlviii. figs. 3–3 *b*), cannot be identical with the present type. On the other hand, the coral figured by Milne-Edwards and Haime under the same name from the Upper Silurian of Britain (Brit. Foss. Cor. pl. lxi. figs. 5, 5 *a*) does really seem to be identical with the form which I have here described.

existed, however, at the angles of the tubes (where alone in this form they could exist), they would certainly be detected in thin sections; and I have not seen any traces of such openings in either tangential or longitudinal slices. In the absence of mural pores the species must be referred to the genus *Monotrypa*, Nich., and it is, indeed, in many respects closely allied to the *Monotrypa undulata*, Nich., of the Trenton Limestone and Hudson-River formation of Canada. The principal characters, in fact, which would distinguish *M. crenulata* from the globular forms of *M. undulata*, Nich., are that the corallites of the former are, on the whole, decidedly larger than they are in the latter, that there are none of the smaller angular corallites which are found among the larger tubes in the latter species, that the thickened nodes at the angles of the larger corallites ("spiniform tubuli"?) in *M. undulata* are wholly absent in *M. crenulata*, and that the walls of the corallites in the English species are decidedly more strongly crenulated than in the Canadian type.

Formation and Locality. Wenlock Limestone, Dudley. Lower Ludlow Shale, Sedgeley (coll. Mr. Madeley).

7. *Monotrypa pulchella*, E. & H.

I have already described and figured this species ('The Genus Monticulipora,' p. 188, figs. 38, 39), and have nothing special to add, except that I find the species to be a more abundant one than I had previously supposed, fragments being not uncommon both at Benthall Edge and Dormington.

EXPLANATION OF PLATE VII.

Fig. 1. Tangential section of *Fistulipora crassa*, Lonsd., sp., enlarged twenty times.

Fig. 1 *a*. Longitudinal section of the same, similarly enlarged.

Fig. 2. Tangential section of another example of *F. crassa*, in which the corallites are of smaller size. Two of the corallites are united by a lateral connecting-tube. Enlarged twenty times.

Fig. 2 *a*. Longitudinal section of the preceding, similarly enlarged.

Fig. 3. Tangential section of *Fistulipora ludensis*, Nich., enlarged twenty times.

Fig. 3 *a*. Part of the same, enlarged fifty times, showing "spiniform tubuli."

Fig. 3 *b*. Longitudinal section of the preceding, enlarged twenty times.

Fig. 4. Outline of a specimen of *Callopora nana*, Nich., of the natural size.

Fig. 4 *a*. Tangential section of the same, enlarged twenty times.

Fig. 4 *b*. Longitudinal section of the same, similarly enlarged.

Fig. 5. Outline of a fragment of *Callopora Fletcheri*, E. & H., of the natural size.

Figs. 5 *a* & 5 *b*. Tangential and longitudinal sections of the same, enlarged twenty times.

Fig. 6. Outline of a specimen of *Callopora? glans*, Nich., of the natural size.

XV.—*Description of a new Genus and Species of Longicorn Coleoptera from the Philippine Islands.* By CHARLES O. WATERHOUSE.

Lamiidæ.

APOMECYNINÆ.

DIAXENES, n. gen.

General characters of *Apomecyna*, but a little less parallel in outline, the elytra being more narrowed towards the apex. Antennal tubercles a little more prominent and more approximate; face equilateral, very gently convex. Eyes coarsely granular, not quite so deeply emarginate. Antennæ reaching two thirds of the length of the elytra, moderately stout, finely ciliate below; the basal joint three times as long as broad, only very slightly narrowed at the base; third a little longer than the first and second taken together, slightly bent, and distinctly narrower at the base than at the apex; fourth joint three quarters the length of the third; the fifth a little more than half the length of the fourth; the following joints gradually but only slightly diminishing in length and thickness. Thorax a little broader than long, subcylindric, a little narrowed in front. Scutellum transverse. Elytra at the base one quarter broader than the thorax, not quite four times as long, moderately narrowed towards the apex, flattened at the suture; at the base, gradually declivous from just behind the middle the apex of each elytron obliquely truncate. Legs short and stout; the femora considerably inflated. Intermediate tibiæ with an incision on the outer edge at the apex. Tarsi short; claws diverging. Prosternal process sloping down posteriorly. Mesosternal process rather broader than the prosternal, sloping down in front.

The species on which I propose to found this genus very much resembles some of the smaller species of *Hathliodes*. It differs from *Apomecyna* chiefly in the proportions of the antennal joints (which also diminish in thickness and are ciliate), the even surface of the thorax, and less parallel form.

Diaxenes Taylori, n. sp.

Pube pallide flavo-grisea dense vestitus; antennarum dimidio apicali fusco, articulis griseo annulatis; thorace ad basin gutta alba notato; scutello fusco, gutta mediana lateribusque albis; elytris ante medium prope suturam gutta fusca; abdomine fusco-vittato, guttis albis utrinque ornato; femorum basi, tibiarum apice tarsisque nigris.

Long. $5\frac{1}{4}$ lin.

The general colour is a pale sandy, with a slightly darker shade at the base and apex of the elytra. Scattered more or less all over the body, including the basal joint of the antennæ and the legs, there are erect white setæ. There are a few distinct punctures on the head between the antennæ. The fourth to the apical joints of the antennæ are blackish brown, with the base of each joint pale. The thorax is very slightly broader than long, moderately narrowed in front of the middle, with a very slight constriction at the base, the sides very gently arcuate; near the base there are a few very distinct punctures; on the basal margin on each side there is a very small fuscous spot. The elytra have the shoulders rounded; some punctuation is visible through the pubescence, there are some small black punctures here and there, and near the scutellum there are numerous larger dark punctures. There is a brown patch on each side of each abdominal segment, and in each patch a small white spot. The legs are nearly white, with the base of the femora dark; the apex of the tibiæ and the tarsi nearly black.

Hab. Philippine Islands? Brit. Mus.

The specimen from which the above description is taken was found alive in the Royal Nursery, Chelsea, on a species of *Orchis* (*Phalænopsis*) from Manilla; it was gnawing off the stems of the plant.

British Museum,
Cromwell Road, S.W.

XVI.—*Generic Characters of the Sponges described in Mr. Carter's "Contributions to our Knowledge of the Spongida"* ('Annals,' 1883, vol. xii. p. 308). By THE AUTHOR.

Order III. PSAMMONEMATA.

Family 1. Surface even, not polygonally divided.

Genus COSCINODERMA, Crtr.

Char. Sieve-like incrustation, composed of foreign bodies, uniformly foraminated and continuously spread over the surface, whose evenness is not disturbed by the usual polygonal projection of the subdermal fibre. Fibre fine, woolly.—Species *Coscinoderma lanuginosum.*

Order V. ECHINONEMATA.

Family 1. Echinated with proper spicules *on* the fibre.

Genus Ectyon, Gray.

Char. Sponge massive, reticulated, composed of cylindrical horny fibre, with single scattered or groups of diverging spicules. Spicules acuate, verticillately spined. (Emended from Proc. Zool. Soc. 1867, p. 515.)—Species *Ectyon sparsus*, &c.

Genus Ectyonopsis, Crtr.

Char. Branched, with solid axis. Spicules with spines generally distributed, *i. e.* not arranged in verticils. Spicules of the interior of the fibre cylindrical, obtusely ended; those on the exterior of the fibre acuate, in groups of two or more, echinating the surface.—Species *Ectyonopsis ramosa.*

Family 2. Echinated with proper spicules projecting from the *interior* of the fibre.

Genus Phycopsis, Crtr.

Char. Fucus-like, branched. Stem hard, woody; covered hirsutely with filamentous processes more or less expanded and divided at the free ends. Spicule acerate.—Species *Phycopsis hirsuta.*

Genus Ptilocaulis, Crtr.

Char. Long, cylindrical branches with solid axis, passing outwardly into more or less spatuliform processes, like the barbs of a feather, more or less divided at the free ends. Spicule acerate or subacuate.—Species *Ptilocaulis gracilis* &c.

Genus Leucophlœus, Crtr.

Char. Pyramidal, erect, in groups, or massive, or flabellate. Surface snow-white when dry. Interior light amber-yellow. Surface incrusted by coalescent tufts of proper spicules. Spicule acerate or acuate.—Species *Leucophlœus massalis* &c.

XVII.—*On some* Histeridæ *new to the Japanese Fauna, and Notes of others.* By George Lewis.

In 1879, twenty-six species of Histeridæ were recorded from Japan, and the present paper treats of twenty-three more. Besides these, there are fourteen species of *Paromalus* and seven of *Saprinus* to be determined, which will bring the Japanese species up to about seventy, when all those contained in my collection are recorded; and it is hardly likely that this list will be much augmented at present, as the rarer Histeridæ are very local, and those which associate with Formicidæ are difficult to find. The eight species marked with an asterisk are such as have allies in the tropical parts of Eastern Asia; the others agree with the Histeridæ of Europe and Northern Asia. The species of *Tryponæus* are worthy of notice, because one of them occurs as far north as latitude 43°, and hitherto Mexico has been the most northern country from which any species has been recorded.

I failed to find *Teretrius* in Japan; but it is the only genus likely to be found in the archipelago which is not as yet represented in the list. *Hister quinquestriatus*, Motsch., given in my 'Catalogue' as no. 663, I now consider = *duodecimstriatus*, Schrank, and *Onthophilus striatus*, F. (? var. Harold), no. 676, = *flavicornis*, Lewis.

In the Histeridæ, as in other families, some of the species from Japan are closely allied to European forms, and I think we cannot refuse to admit the probability of a common origin for both at no very remote period; so that a close comparison and careful study of such insects as *Hololepta plana* and *depressa*, *Hister unicolor* and *concolor*, or *Hetærius gratus* and *ferrugineus*, will perhaps show the direction that modification may assume in like forms when isolation is fairly complete, as in Japan, and the conditions realized within the area are sufficiently potent to produce a visible effect. It may be said that it is only incidentally that *Hister concolor* and *Hololepta depressa* can be distinguished from their European congeners by a densely punctured pygidium: but the incident does not lie simply in their having it; it lies in the fact that both from their habits have been subjected to certain conditions which cause such sculpture.

The most essential differences between any part of Europe and Japan are shown in the climate and other physical conditions, which in the latter country nourish great forests of magnificent timber even at fairly high altitudes, while in

Europe forests relatively occupy an insignificant area, and such trees as grow in favourable situations never attain to the vigour and consequent stature of those in the East.

List of Species, arranged generically.

Hololepta depressa, n. sp.
—— parallela, n. sp.*
—— amurensis, *Reitter*.
Platysoma pini, n. sp.*
—— Lewisii, *Marseul* *.
—— vagans, n. sp.
—— rasile, n. sp.
—— celatum, n. sp.
—— lineicolle, *Marseul*.
Hister japonicus, *Marseul*.
—— 12-striatus, *Sch.*
—— punctulatus, *Wied.**
—— aino, n. sp.
—— Jekeli, *Marseul*.
—— concolor, n. sp.
—— Pirithous, *Marseul*.
—— cadaverinus, *Hoffm.*
—— boleti, n. sp.
—— agnatus, n. sp.
—— sutus, n. sp.
—— navus, *Marseul*.
—— depistor, *Marseul*.
—— japanus, *Motsch.*
—— margine-punctatus, *Lewis*.
—— simplicisternum, *Lewis*.
Carcinops 14-striata, *Steph.*
Epierus lucûs, n. sp.
Paromalus musculus, *Marseul*.
Notodoma fungorum, n. sp.*
Hetærius gratus, n. sp.
—— optatus, n. sp.
Dendrophilus Xavieri, *Marseul*.
Triballus semen, n. sp.
Saprinus speciosus, *Er.*
—— pecunius, *Marseul*.
—— nitidus, *Payk.*
—— sinæ, *Marseul*.
Gnathoncus rotundatus, *Ill.*
Tryponæus fagi, n. sp.*
—— venator, n. sp.*
Plegaderus Marseuli, *Reitter*.
Onthophilus flavicornis, n. sp.
—— ostreatus, *Lewis*.
—— silvæ, n. sp.
—— arboreus, n. sp.*
Abræus bonzicus, *Marseul*.
Bacanius niponicus, *Lewis*.
Acritus Komai, *Lewis*.
Myrmidius ovalis, *Beck.*

The new species are :—

Hololepta depressa, n. sp.

H. planæ proxime affinis, nigra, nitida ; pronoto stria marginali tenuissima ; elytris striis 2 dorsalibus abbreviatis ; pygidio dense punctato. L. $6\frac{1}{2}$ mill.

Exceedingly like the European *H. plana* ; the head and prosternum are both narrower, and the pygidium thickly and rather coarsely punctured.

Distributed sparingly from the Kumagawa in Higo to the Ishikari river in Yezo. All the specimens taken were resting under bark, and generally on the lateral branches 12 or 14 feet from the ground.

Hololepta parallela, n. sp.

H. elongatæ proxime affinis, parallela, valde plana, nigra, lævissima ; fronte non tuberculata ; elytris stria subhumerali brevissima ;

abdomine subtus plano: propygidio utrinque sulcato, pygidio impunctato. L. 7 ad 8 mill.

This species is like *H. elongata*, but it has no tubercle on the head, nor is there an arched sulcus in the third (the broadest) segment of the abdomen beneath. The sides of the thorax are more rotundate, and each elytron has one short stria at the base. These characters, joined to the broader outline and facies generally, are of good specific value.

I obtained a series of twenty specimens in the moist forests of Higo in May, chiefly at Konose and Yuyama; it is the most tropical form of the genus in Japan, and is found under the bark of both the hard-wooded evergreens and the deciduous trees.

Hololepta amurensis, Reitter.

Hololepta amurensis, Reitter, Deutsche ent. Z. xxiii. (1879) p. 213.

The male of this species has a deep thoracic fossa. It was described by Herr E. Reitter from Amurland, as the trivial name indicates, and I found it commonly in all the forests of Japan of moderate elevation. I have beaten it in plenty near the Junsai lake in August, off the branches of *Salix* infested with *Cossus*.

Note.—Some of the Histerids of the *Hololepta* group with simple mandibles are not strictly entomophagous in the imago state; and this is particularly the case with *H. amurensis*, which, I believe, feeds exclusively on exuding sap. *Hololepta elongata*, which I have taken plentifully in Ceylon and other places, is probably (with *H. parallela*) wholly dependent on small soft-bodied larvæ for food, and I have never seen *H. depressa* at sap.

Platysoma pini, n. sp.

Ovale, subconvexum, nigrum, nitidum, læve; fronte clypeoque concavis, stria transversa integra; pronoto stria non interrupta; elytris striis 1–4 integris, 5 breviori, 6 nulla; propygidio biimpresso, pygidio margine elevato, grosse punctatis; antennis pedibusque brunneis. L. 5 mill.

Closely allied to *H. odiosum* (*Marseuli*, Cand.), but smaller; with a different system of dorsal striation.

Occurs under pine-bark in the warmer parts of Japan; Higo and Isei are the chief localities for it.

Platysoma vagans, n. sp.

Oblongum, parallelum, subconvexum, nigro-piceum; fronte subconcava, stria recta; pronoto punctulato, stria integra; elytris striis 1–3 integris, 4–5 abbreviatis, 6 nulla; propygidio pygidioque grosse punctatis et immarginatis; pedibus rufis. L. $4\frac{1}{2}$ mill.

This species comes near to *P. Lewisii*; it is less convex, more parallel, with the fourth and fifth striæ shortened from the middle; the pygidium is emarginate and convex.

I obtained it from an oak near Bibi, in South Yezo, August 16, 1880.

Platysoma rasile, n. sp.

Oblongum, subparallelum, depressum, nigrum, nitidum, læve; fronte concava, stria integra; pronoto lateribus sparse punctatis, stria pone oculos utrinque angulata; elytris striis 1–3 dorsalibus integris, 4–5 abbreviatis; propygidio pygidioque fortiter punctatis. L. $3\frac{1}{2}$ mill.

This species is very close to *P. Lecontei*; it is more parallel and less quadrate, but the general sculpture above is almost identical. Beneath, the segments of the abdomen are of equal breadth, not contracted in the middle, as in *P. Lecontei*; and in this particular there is a like modification to that hereafter noticed between *Hister Ariasi* and *Hister aino*.

I took a few examples at Kumamoto and Konose in Higo.

Platysoma celatum, n. sp.

Oblongo-ovatum, nigrum, nitidum; fronte subconcava, stria recta; pronoto antice rufo, lateribus punctulatis, stria transversa interrupta; elytris striis 1–4 integris, 5 abbreviatis; propygidio pygidioque punctatis; antennis pedibusque rufo-brunneis. L. 3 mill.

This species is allied to the preceding (*P. rasile*), but the striation is different and also the coloration.

Occurs in the vicinity of Yokohama in "fir-stools" early in spring.

Hister aino, n. sp.

Ovalis, convexus, niger, nitidus; pronoto lateribus late punctatis, stria integra, margine angusto, elevato; elytris striis 1–4 dorsalibus integris, quinto et suturali abbreviatis; propygidio sparse punctato, utrinque subfoveolato, in medio linea longitudinali distincta; pygidio dense et grosse punctato. L. 8 mill.

This insect in its general sculpture agrees with the rare European *H. Ariasi*, but it has not the subparallel outline of that species. This shortness or more ovate form as compared with *H. Ariasi* arises from the structure of the abdominal segments. In *H. Ariasi*, the segments of the abdomen beneath are of equal breadth; in *H. aino*, the three median segments are narrow and only clearly visible at the sides, for in the middle they are soldered together, and a few punctures alone remain to indicate their limits. The broad lateral band of punctures on the thorax separates it from all the other Histerids in Japan; but it may be placed in the catalogue near *H. Jekeli.*

This peculiar *Hister* has been found in the district of the Ishikari river in Yezo.

Hister concolor, n. sp.

Ovalis, subconvexus, niger, nitidus; fronte stria integra; pronoto stria laterali externa valde, interna vix abbreviatis; elytris striis 1–3 integris, 4–6 brevibus; propygidio subfoveolato pygidioque dense et grosse punctatis. L. 8 mill.

H. concolor is sculptured like *H. unicolor*, except on the two abdominal segments seen from above, which are strongly and closely punctured. In its general facies it is like *H. 4-notatus*, being wider and less convex than *H. unicolor*, and the interstice between the inner thoracic stria and the outer margin is wider and the short stria is more in the centre of this interstice.

This is also from the vicinity of the Ishikari river.

Note.—I found three specimens of *Hister japanus*, Motsch., on the beach at Yokohama; it comes near *H. 4-notatus*, Scriba.

Hister boleti, n. sp.

Ovalis, convexus, niger, nitidus; fronte plana, stria integra profunde impressa; pronoto striis punctatis, stria pone oculos utrinque deflexa; elytris striis crenatis, 1–3 dorsalibus integris, 4, 5, et suturali brevibus; propygidio subfoveolato pygidioque punctatis; mesosterno leviter sinuato. L. 7 mill.

This species is the size of *H. cadaverinus*, but in general sculpture comes nearest to the rare European *H. distinctus*. From the latter, the longer mandibles, the remarkable deflexure in the thoracic stria behind the eyes, the fourth dorsal stria not reaching the middle, and the sinuate mesosternum (as in *H. cadaverinus*) are good distinguishing characters.

It occurs commonly at Chiuzenji in an arboreal fungus, and I also obtained it at Kashiwagi in the Kii peninsula.

Hister agnatus, n. sp.

Ovalis, subconvexus, niger, nitidus; pronoto striis lateralibus integris, postice approximatis; elytris striis 4 dorsalibus integris, 5 et 6 abbreviatis; prosterno impunctato. L. 5 mill.

This species is almost identical with *H. cadaverinus* as regards sculpture, but it is much less convex. It is not larger than *H. fœdatus*, which it resembles in the structural plan of its abdominal segments and also in its outline. *Hister fœdatus* and *marginicollis*, with *H. aino* and *agnatus*, have segments 2–4 of the abdomen much contracted in the middle; and the result of this is that the pygidium is reflexed by being drawn up towards the sternum.

I obtained my specimens from a dead fowl, set as a trap for necrophagous insects, at Nikko, in the forest behind the temples, in June 1880.

Hister sutus, n. sp.

Suborbicularis, convexiusculus, niger, nitidus; stria frontali subtransversa; pronoto subtiliter et parce punctulato; elytris striis 1-3 integris, 4 ante basin abbreviata, 5 et 6 ante medium terminatis; prosterno basi bistriata; mesosterno sinuato, margine punctato-striato. L. 4 mill.

This species is of the same stature as *H. ruficornis*, and possesses some of its characters, but the two thoracic striæ bring it into the *H. cadaverinus* group.

It is apparently rare. I obtained only four specimens from the elevated forest above Kiga, near Miyanoshita, in May 1880.

Epierus lucûs, n. sp.

Ovalis, parum convexus, niger, nitidus; antennis rufis, pedibus piceis; pronoto punctulato; elytris striis 5 dorsalibus et suturali integris; propygidio pygidioque dense punctatis. L. $2\frac{1}{2}$ mill.

Larger and more ovate than *E. comptus*; the head is very finely punctured, with a transverse stria between the eyes. The thorax is clearly punctate, and rather thickly so at the base, in front of the scutellum; the interstices of the elytral striæ are all finely punctured.

The type of this species came from a rotten tree in the grounds of the Kasuga no Miya, at Nara, June 1881, and I believe all the species of this genus are of arboreal habits. I have only one specimen.

Notodoma fungorum, n. sp.

Globosum, rufo-castaneum, nitidum, punctatum; elytris punctato-striatis, 1, 2 et 4 integris, 4 antice cum suturali arcuatim juncta; tibiis multispinosis. L. $3\frac{1}{2}$ mill.

When in Paris, I carefully compared this species with Marseul's type of *N. globatum* from India, and found it distinct, but closely allied. The size is larger and the punctuation more coarse, and there is a slight difference in the form of the striæ. On the humeral angle, and in the space between the second and fourth stria at the base of each stria, there is a large cream-coloured blotch; this, with the prevailing red colour of the species, is a very remarkable feature for the family.

It is not uncommon in all the islands, infesting fungi on trees, which it visits in the first stage of decomposition, when there is an abundance of other insects, on the larvæ of some of which it doubtless feeds.

Hetærius gratus, n. sp.

Subquadratus, rufo-brunneus, fulvo-hispidus; fronte lateribus striatis; pronoto utrinque bisulcato; elytris striis 3 distinctis, 3 brevi; pygidio parce punctato, tenuissime impresso. L. $1\frac{1}{2}$ mill.

This species is very closely allied to *H. ferrugineus*; it is darker in colour, half as large again, with legs relatively much longer and tibiæ much more dilated. The elytral striæ are three in number, two complete, and the third only as long as two thirds of the elytra.

I took this species with a fuscous-coloured ant, midway between Shimonosuwa and the Wada-toge, August 1, 1881.

Hetærius optatus, n. sp.

Oblongo-ovatus, nigro-piceus, sparse fuscescenti-hirtus, punctulatus; pronoto lateribus subrotundatis, margine latissimo, medio bistriato; elytris striis 1–3 et suturali integris; pedibus rufis, tibiis modice latioribus. L. 2 mill.

I have only a single example of this curious *Hetærius*, which differs in colour and outline from all the hitherto recorded species. The whole insect is piceous black, save the anterior angles of the thorax and the legs, which are red. The thorax has the lateral margin very wide, with two short fine striæ in the centre; these lines are not, as may at first appear, the limit of the thoracic margin. The thorax, especially in the anterior portion, is much more coarsely punctured than the elytra.

I received this species from the vicinity of the Ishikari river, in Yezo, and with it came specimens of a genus of Synteliidæ (not yet enunciated), which corresponds with *Cylistix* in the Histeridæ, and it is probable that they all came from the same tree. I think, therefore, that *H. optatus* has been taken in association with an arboreal ant; and this idea seems confirmed by the colour of the species, which agrees somewhat with *Dendrophilus punctatus* or a dark-coloured *Eretmotes*.

Triballus semen, n. sp.

Ovalis, parum convexus, dense punctatus, nigro-piceus, parum nitidus; fronte post oculos subtuberculata; elytris striis dorsalibus 2 abbreviatis, obsoletis. L. 2 mill.

Allied to *T. americanus*, but more convex, with the forehead behind the eyes more elevated, the elytra strigose-punctate at the sides, and the margin simple, not reflexed.

I have only one specimen; it was taken in an old tree at Kiga, near Miyanoshita, May 1880.

Tryponæus fagi, n. sp.

Cylindricus, niger, nitidus, undique punctatus; antennis pedibusque rufo-piceis. L. 4 mill.

♂. Frontis lateribus basisque margine elevatis; pronoto antice retuso, medio subelevato.

♀. Fronte plana, in medio depressa; pronoto antice convexo.

T. kalemantenus is rather shorter and broader than this species, but the two are nearly allied. The prosternum in *T. fagi* has no lateral stria, and the thoracic marginal line continues well round the basal angles.

The perfect insects of *Tryponæus* prey on those of *Platypus*, and it is useless seeking for the former in trees not infested by the latter, which go 6 or 8 inches into the trees and are followed by the Histerids. It is impossible to say from observation whether the spines or processes on the apices of the elytra of the wood-borers protect them in any way from their enemies, but I think they do not, and that they have other uses. *Tryponæus* cannot turn round in the trees, but can move backwards or forwards in the narrow galleries with almost equal facility. It can only be caught, as a rule, when traversing the distance between two holes; but I have beaten stray specimens in summer.

Tryponæus venator, n. sp.

Niger, nitidus, filiformis, parum dense punctatus; antennis pedibusque piceis; prothorace stria laterali integra, prosterno utrinque striato. L. $3\frac{1}{2}$ mill.

♂. Rostro apice modice reflexo, thorace antice linea in medio vix elevata.

♀. Fronte excavata.

This species is more filiform than any other I know from Asia, and is remarkable for its cylindricity, because the eastern forms of the genus are usually much more robust than the American species. *T. venator* feeds on a much smaller *Platypus* than *T. fagi*; each species preys, in fact, on an insect of its own girth. The male has the thorax a little longer than the female and slightly compressed at the sides.

Found only in South Japan, at Yuyama and Konose, but it is not rare where it occurs.

Onthophilus flavicornis, n. sp.

Breviter ovalis, niger, subnitidus; antennis brunneis, clava flava; fronte in medio unicostata; pronoto dense strigoso, margine angusto, subelevato; propygidio tricarinato. L. 2 mill.

The sculpture is very similar in every respect to that of the European *O. striatus*; the distinguishing characters are the colour of the antennæ, and the sides of the thorax being only very narrowly margined, and not elevated at the base. There is a slight difference also of outline, and some of my remarks on *Hister concolor* will apply to this species.

Taken from a fungus at Bukenji, near Yokohama, early in March 1880.

Onthophilus ostreatus, Lewis.

Onthophilus ostreatus, Lewis, Ent. Mo. Mag. xvi. 1879, p. 76.

This species, which is the largest yet known in the genus, was formerly only recorded from China. In the autumn of 1880 Mr. Pryer obtained a fair series near his bungalow at Yokohama, from refuse in a turnip field, and I am indebted to him for four examples.

Onthophilus silvæ, n. sp.

Suborbicularis, niger, opacus; fronte triangulariter carinata; pronoto parce tenuissime punctato, costis octo validis, duabus tantum abbreviatis; elytris sutura, margine laterali costisque duodecim, elevatioribus. L. $2\frac{1}{2}$ mill.

The outline of this species in the head and thorax resembles that of the American *O. alternatus*, but the insect is a little smaller. The thorax has eight costæ, six complete, two (the third from the margin on each side) very short, with the punctuation of the intervening spaces very scattered and shallow. The elytra have twelve costæ complete and equally elevated, the suture and margin corresponding with them; the interstices have at intervals a transverse line-like puncture, but none of the longitudinal punctures which are so general in this genus.

Found under dead leaves at the Akinomiya, near the Suwa lake, July 31, 1881.

Onthophilus arboreus, n. sp.

Orbicularis, niger, hispidus, opacus; antennis clava ferruginea. *O. hispido* proxime affinis, sed minor. L. $1\frac{1}{3}$ mill.

This insect has the dorsal punctures much less deep than in

O. hispidus; it must, however, be observed that the species of this section of *Onthophilus* are very difficult to define, as, when in good condition, they are covered with minute spines and mud-like scales, and it is impossible to see the sculpture. As in the genus *Dastarcus*, the specific differences are very slight. All the hispid species are arboreal in habit; the specimens I have from Japan were residing in galleries of wood-borers, probably *Tomicus*, and were 8 or 10 inches from any orifice by which they could emerge. In Ceylon, I found *O. hispidus* in the same way, obtaining a large number in one tree; and M. Raffray, under similar conditions, found *O. costipennis* (also a hispid species) in the island of Zanzibar.

The locality for *O. arboreus* is the forest behind the large temple at Nara, in Hawatchi, where I took it in June 1881.

PROCEEDINGS OF LEARNED SOCIETIES.

DUBLIN MICROSCOPICAL CLUB.

February 15, 1883.

Magnetic Iron-Sand.—Dr. Frazer showed a specimen of magnetic iron-sand, of which the crystals were of brilliant adamantine lustre, and showed several modifications of the primary form; these displayed marked polarity when acted on by an artificial magnet, arranging themselves in bead-like strings.

Starch-granules (?) *remaining in the Ash of Platinotype Photographic Paper.*—Mr. Greenwood Pim showed a preparation of the ash of platinotype photographic paper after treatment with potass oxalate developer. Imbedded in the fibre of the paper were bright blue semitransparent bodies, somewhat rounded, and which dissolved in hot nitric and hydrochloric acids; but cold acid did not appear to produce much effect. They were considered to be a peculiar form of starch-granule in the sizing of the paper.

Nauplius-stage of Astacus.—Prof. Haddon showed the Nauplius-stage of *Astacus fluviatilis,* also the similar stage of a Cirripede for comparison.

Penium rufopellitum, Roy, *from Connemara, exhibited, to show the Exfoliation of the external reddish Cortical Coating.*—Mr. Archer showed examples from Connemara of *Penium rufopellitum*, Roy, a remarkable, if not very striking, Desmid. It is curious, as would seem, that this species has not been found out of the United Kingdom, one station being in Scotland, near Aberdeen, originally found by Mr. Roy; the other being at Connemara, and found by Mr. Archer. It probably most resembled *Penium cylindrus* (of which Mr. Archer now showed an example); but it is very distinct indeed. This form, *P. rufopellitum*, is of a brownish-red colour, due to an external roughish bark-like coating, which is occasionally shed from a portion of the superficies, the bare portion of the wall being then seen to be colourless. There does not seem to be any other species with this curious characteristic; the reddish colour and roughish granular superficies belonging to *Penium cylindrus* do not appear to be due to an outward coating capable of exfoliation.

March 15, 1883.

Vaucheria sessilis showing septation.—Dr. E. Perceval Wright exhibited some specimens, which had been some years mounted, of *Vaucheria sessilis*, showing the septation of this form, which was to be met with in the winter or early spring months. His object in doing so was to direct attention to Dr. M. C. Cooke's "Notes on *Vaucheria*" in the current (March) number of 'Grevillea,' in which he describes and figures septation of the filaments in a *Vaucheria*, stating that such had not been previously recognized. In a footnote Dr. Cooke remarks that the septation which he figures differs materially from that detailed by Stahl (Bot. Zeit. xxxvii. p. 129); but is this so? for the species described are not the same. Be this as it may, Hanstein, in 1872, has noticed the appearance of partition-walls in *Vaucheria*; and Schaarschmidt, judging from a short analysis of his paper, written in Hungarian in November 1882 ('Biologisches Centralblatt'), had also done the same. The specimens exhibited had been observed by Dr. Wright in 1879.

Echinobotryum atrum, Corda.—Mr. Greenwood Pim showed *Echinobotryum atrum*, Corda. This curious fungus is found parasitic on the stems of certain moulds, usually in this case *Stysanus* or *Pachnocybe*. It consists of groups of pear-shaped nearly black spores, resembling perithecia. It is referred to the Torulacei by Cooke, but its affinities with that group seem very doubtful. Something like mycelium was noticed in one or two instances. Possibly culture may reveal something more of its history. The present example appeared in abundance on the cut surface of an elm-branch at Monkstown.

Haliphysema Tumanowiczii new to Ireland.—Prof. Haddon showed *Haliphysema Tumanowiczii* from Dalkey Island, taken in 1882, the first recorded Irish example.

Cosmarium plicatum, Reinsch, *forma majus, from damp walls in a warm House at Glasnevin Botanic Garden.*—Prof. M'Nab showed some gelatinous stuff from the walls of one of the warm houses at Glasnevin Botanic Garden, formed by the confluent mucous envelopes of Phycochromaceous Algæ, as frequently occurs on damp rocks in subalpine spots, but here rather unexpectedly showing imbedded certain *Cosmaria*. Prominent amongst these was the large and on the whole decidedly rare rock-form *Cosmarium plicatum*, Reinsch, forma *majus*. Doubtless under the name *Cosmarium plicatum*, Reinsch had in view two very distinct things, both indeed rare, although the smaller one is somewhat more frequently met with and usually in somewhat greater numbers than the "forma *majus*." This, the present one, occurs both in Ireland and Scotland, specimens from those wide-apart sources being absolutely identical.

Cosmarium acanthophorum, Nordstedt, *exhibited to show that the form appertains rather to Xanthidium.*—Mr. Archer showed the so-called *Cosmarium acanthophorum*, Nordstedt, also *Xanthidium Nordstedti*, Reinsch, showing how closely they approached one another, and expressing some wonder that Nordstedt should relegate such a form to *Cosmarium* at all, his name seeming to involve what might be almost regarded as a contradiction in terms as is expressed in the designation "spine-bearing *Cosmarium*."

Ammodiscus Scharmanni new to Ireland.—Mr. Balkwill, amongst many beautifully mounted Foraminifera, showed *Ammodiscus Scharmanni*, new to the Dublin fauna.

Air-bubbles in Water-cavities of Quartz.—Prof. Hartley showed some good and striking examples of air-bubbles in water-cavities of quartz.

April 19, 1883.

Specimens of Torrubia (Cordyceps) exhibited.—Mr. Pim showed one of the strange group of Sphæriaceous Fungi parasitic on insects, formerly called *Cordyceps*, now referred to *Torrubia*. The specimens were from the herbarium of Trinity College, and were identified by the Rev. M. J. Berkeley as *Torrubia* (*Cordyceps*) *Gunniæ*, natives of Van Diemen's Land, whence they had been sent to the late Professor Harvey. The sections showed very long slender sporidia having a seemingly chain-like structure, or like a number of dumb-bells ranged end to end. Further maceration in caustic potash resolved them into a series of transverse ridges across each sporidium, with small globules between each pair of ridges. The sporidia, though long, are extremely slender, so that it is very difficult to make out their structure. Specimens of *Torrubia Robertsii* from New Zealand were shown for comparison.

Microthamnion Kützingianum exhibited.—Mr. Crowe showed examples of that minute arborescent Alga *Microthamnion Kützingianum*, somewhat widely distributed, but always scantily represented and fitful in appearance. It forms an elegant very tiny little bushy tuft of bright green colour.

Budding in Polyzoa.—Prof. Haddon showed budding state of Polyzoa, illustrating late union of the lophophore with the stomach, and the origin of part of a bud from the endocyst and part from the funiculus.

Augite Crystal.—Prof. V. Ball exhibited a transverse section of an augite crystal from the Vesuvian lava of 1794. Under polarized light this is a very beautiful object, and exhibits striæ which mark the position of a plane of twinning. A photograph of it, magnified about 25 diameters, taken by Prof. G. F. Fitzgerald, represents this character, some included cells, and the structure of the matrix with admirable definition. The photograph was taken by electric light.

Foraminifera from the Vienna Basin.—Mr. Elcock showed a fine series of mounted (fossil) Foraminifera from the Vienna basin, remarking that many were identical with those from oceanic collections made during the expedition of H.M.S. 'Challenger,' in fact in no way distinguishable.

Alliospora sapuçayæ, Pim, *further phases.*—Mr. Pim drew attention to the fungus shown by him last year, and provisionally named *Alliospora sapuçayæ.* The description in the Club Minutes, though correct in so far as it went, proved on further investigation imperfect, inasmuch as the spore-bearing hyphæ do not originate, as was thought, directly from the globose columella, but from a layer of somewhat wedge-shaped closely packed cells forming an outer coat, whose thickness is twice or thrice the diameter of the columella. The sporiferous hyphæ, moreover, are frequently branched articulately at the tip, where spores are formed, as in the genus *Penicillium.*

May 24, 1883.

Pileolaria terebinthi exhibited.—Mr. Pim showed *Pileolaria terebinthi,* a native of Genoa, from specimens in the herbarium at Trinity College, Dublin. This curious rust is technically a *Uromyces*, but the lenticular spores with extremely long slender pedicels are abundantly distinct from any ordinary form of that genus.

Section of Stem of Lycopodium.—Prof. M'Nab exhibited a transverse section of the stem of a species of *Lycopodium*, probably *Lycopodium ilicifolium,* from a plant growing in the stove at Glasnevin. The central fibro-vascular cylinder presented a peculiar complicated appearance on account of its construction, the xylem and phloem being partly concentric, partly radial, according to the types of DeBary. The centre was concentric, whilst the periphery of the axile cylinder consisted of alternating radial bundles of xylem and phloem.

A problematic Organism.—Dr. E. P. Wright showed a mounted specimen of a peculiar and problematic organism which he had found in some quantity, quite incrusting the root-like portions of one or two deep-sea alcyonarians. The specimens shown, though mounted dry, had been quite lately in strong spirit, into which they had, without doubt, been plunged on coming out of the sea. The organism, which was found in the form of thin, creeping, chain-like masses, consisted of a stoloniferous portion, from which arose a forest of trichome-like bodies all about the same length, and all terminating in a star of from five to six rays. These bodies, like the stoloniferous body-mass, were all formed of calcic carbonate, which, in spirit-specimens, seemed to be invested with a thin homogeneous plasmodic layer of a protoplasmic nature. While inclined to ascribe to this form Rhizopodal affinities, Dr. Wright found it quite impossible to do this with any certainty. With the crystal bodies in some Ascidians (in which these bodies form separate entities, and not, as here, part of a common mass) he fancied the exhibited specimens had nothing in common. The few remains of siliceous spicules entangled in the trichome-like bodies had obviously nothing to do with the strange but beautiful organism.

Spirotænia acuta, Hilse, *not strictly appertaining to the genus, though of similar habit.*—Mr. Archer showed some examples of a not uncommon, though local, unicellular Alga, doubtless that usually regarded as *Spirotænia acuta*, Hilse, but in which, in fact, he never could distinguish any trace whatever of a spiral arrangement of the chlorophyll-mass, so characteristic in *Spirotænia condensata*, *Sp. closteridea*, *Sp. truncata*, and *Sp. parvula*. No doubt the plant has the habit and the same kind of occurrence as those named, the young just-divided individuals hanging together in the same way in pairs in the sharply defined common investing mucous matrix. This plant, then, like *Spirotænia obscura*, so-called, he could hardly think was truly a *Spirotænia* at all, but approached more to *Penium*, the central axile (not parietal) mass of contents being only somewhat twisted.

June 22, 1883.

Fruit of Cliftonia.—Dr. E. Perceval Wright exhibited some mounted fragments of *Cliftonia pectinata*, Harv., which he had quite recently received from Baron F. von Müller, and which had been dredged by Prof. Bracebridge Wilson outside Port Phillip Head. These specimens showed ovate ceramidia, which were developed from the points of emergence of the pectinate ramelli of the frond. Harvey had never seen the species in fruit, but hazarded the conjecture that the ceramidia would prove to be, as in *Claudia*, formed out of contracted phyllodia; but it will be seen that the actual phenomenon is different from this, and adds one more to the characteristics of the genus *Cliftonia*. So far the tetrapores of this species remain undescribed.

Section of Ailsa Crag Rock.—Prof. Hull, F.R.S., exhibited a thin section of the rock of which Ailsa Crag, at the entrance to the Firth of Clyde, is formed. It is a grey felsitic rock, composed of crystals of orthoclase, grains of quartz, a few needle-like crystals of hornblende, and a little chlorite, all of which are set in a felsite paste. With a high power the grains of quartz are seen to contain numerous gas-cavities, remarkable for their angular and crystalline forms; others contain a fluid, and show a small bubble. Prof. Hull explained the supposed origin of this remarkable rock, as having been the consolidated core of an ancient volcano, from which the loose materials, originally forming the sides of the volcanic cone, had been stripped off by denudation, thus leaving the solid core standing alone.

Staurastrum mesoleium, n. s., *exhibited.*—Mr. Archer drew attention to a *Staurastrum* form, which, though not quite peculiar to Callery Bog, seems to have its headquarters there. He had once or twice seen it from Connemara, and he suspected it may probably be the same as a form mentioned by Mr. Roy as having been found at Scorston Moor, near Aberdeen; but Mr. Archer had never seen examples from there. Mr. Roy had suspected his form, at any rate, to come near to *Staurastrum oligacanthum*, non Bréb., but as once understood by Herr Nordstedt; but the latter, as he since acknowledged, is wholly a different thing from *St. oligacanthum*, Bréb. (rare enough in Ireland), and he had proposed to name the Swedish form *Staurastrum mediolæve.* But the Callery form (and possibly, as mentioned, the Aberdeen form too) seems to be, indeed, altogether different from the Swedish form, now to be known as *St. mediolæve*, Nordstedt. The Callery form is a pretty one, about medium-sized, triangular in end view, in front view the angles a little produced, slightly spinulose. From its resemblance (albeit distant) to, and its association, for the time being, in our ideas, with the Swedish form (although neither name appears very appropriate), Mr. Archer would propose to designate the present form by the (companion) name *Staurastrum mesoleium.*

GEOLOGICAL SOCIETY.

December 19, 1883.—J. W. Hulke, Esq., F.R.S., President, in the Chair.

The following communication was read:—

"On some Remains of Fossil Fishes from the Yoredale Series at Leyburn in Wensleydale." By James W. Davis, Esq., F.G.S.

After describing the nature and succession of beds among the rocks which yielded the fossils under consideration, the author discussed the conditions under which they were deposited. He pointed out that the Fish-fauna of the Yoredale series was distinguished by some important peculiarities from that of the Mountain Limestone below, as also from that of the Coal-measures. Some of the Carboniferous-Limestone types are represented only by very small specimens in the Yoredale series; certain Coal-measure fish make their first appearance in these Yoredale beds; but a large proportion of the species in the latter are peculiar to the formation.

Of the thirty-four species cited twenty are identified with known Carboniferous-Limestone forms, namely:—*Cladacanthus paradoxus*, Ag.; *Physonemus hamatus*, Ag.; *Cladodus mucronatus* and *Hornei*, Davis, and *C. striatus*, Ag.; *Pristicladodus dentatus*, McC., and *concinnus*, Davis; *Glyphanodus tenuis*, Davis; *Petalodopsis tripartitus*, Davis; *Polyrhizodus Colei*, Davis; *Diclitodus scitulus*, Davis; *Petalodus acuminatus*, Ag.; *Pleurodus Woodi*, Davis; *Pœcilodus corrugatus*, Davis; *Lophodus reticulatus*, *serratus*, and *bifurcatus*, Davis; *Psammodus rugosus*, Ag.; *Copodus cornutus*, Ag.; and *Ctenopetalus crenatus*, Davis. The Coal-measure species, *Megalichthys Hibberti*, is also cited. The remaining thirteen species are described as new; they are:—*Chomatodus lamelliformis*, *Sandalodus minor*, *Lophodus conicus* and *angularis*, *Deltoptychius plicatus*, and the following, which are regarded as the types of new genera: *Gomphacanthus acutus*, *Hemicladodus unicuspidatus*, *Astrabodus expansus*, *Cyrtonodus gibbus*, *Echinodus paradoxus*, *Diplacodus bulboides*, *Mycetodus verrucosus*, and *Cercidognathus canaliculatus*.

In conclusion the author noticed the occurrence, associated with the above, of some very fragmentary remains, apparently belonging to a Labyrinthodont, a portion of which have already been described by Prof. Miall in the 'Quarterly Journal' (vol. xxx. p. 775). These remains consist of parts of the head and of one hind limb.

January 9, 1884.—J. W. Hulke, Esq., F.R.S., President, in the Chair.

The following communication was read:—

"On further Discoveries of Vertebrate Remains in the Triassic Strata of the South Coast of Devonshire, between Budleigh Salterton and Sidmouth." By A. T. Metcalfe, Esq., F.G.S.

The author gave a brief stratigraphical account of the Triassic rocks of the coast. He then described some vertebrate remains, consisting chiefly of portions of jaw-bones with teeth in line, probably of Labyrinthodonts, found in the Upper Sandstones (Ussher's classification) at High Peake Hill, near Sidmouth, by H. J. Carter, Esq., F.R.S. At numerous places between Budleigh Salterton and Sidmouth Mr. Carter and the author had found a large number of isolated bone fragments. Such fragments had been submitted to a microscopical examination by Mr. Carter. In some specimens the bone structure was visible throughout; in some the bony portion had been partially removed and replaced by an infiltration of mineral matter; in others the removal of the bony portion was complete. From these facts the author drew the conclusion that a comparative abundance of vertebrate life was maintained during the

Triassic period; and that the rareness of Triassic fossils was due not so much to the paucity of animal life during that period as to the fact that Triassic strata afforded no suitable conditions for the *preservation* of organic remains.

MISCELLANEOUS.

On the so-called Dimorphism in the Genus Cambarus. By Walter Faxon.

The existence of two forms of the adult male in all the species of the genus *Cambarus* was discovered by Louis Agassiz and Henry James Clark. The differences between the two forms affect more especially the first pair of abdominal appendages, organs concerned in the act of coition, but also extend to the general form and sculpture of the body. In one form (unhappily called by Dr. Hagen the "second form"), the first pair of abdominal appendages have a structure nearly like that seen in all *young* males. The hooks on the third joint of the third (in some species of the third and fourth) pair of legs are small, and in the sculpture of the shell and shape of the claws this form approaches the female. In the other form (Hagen's "first form"), the articulation near the base of the first pair of abdominal appendages is gone, and the whole member is much more highly specialized, the terminal hooks being horny, more widely separated, and in every way more highly developed; in those species with bifid tips to these appendages the branches are longer, slenderer, more widely separated, and stiffer; the hooks on the thoracic legs are longer and more perfectly finished; the sculpture of the whole body is more pronounced, and the claws are larger and more powerful. No intermediate conditions are found, and there is no relation between these forms and the size of the individual, the "second form" being large and the "first form" small, or *vice versâ*. Hence we are forbidden to interpret the two forms as stages in ordinary development. Dr. Hagen has shown that in individuals of the "second form" the internal generative organs are smaller than in the "first form," but having only alcoholic material he was unable to determine any thing concerning the presence or absence of spermatozoa. He interprets the facts as a case of dimorphism, and surmises that the "second form" males are sterile individuals.

In the autumn of 1875 I received a lot of living *Cambarus rusticus*, Girard, from Kentucky, males of the "first form" and females, which bred freely in confinement. After pairing, three of the males moulted, and were thrown, while in the soft-shelled state, into alcohol, together with their exuviæ. An examination of these specimens now reveals the fact that the soft-shelled specimens are all of the "second form," their exuviæ of the "first form"! After attaining the "first form" and after pairing the same individual has reverted to the "second form." It is now clear that we are not dealing with a case of true dimorphism, such as is well known among insects and plants, but it appears probable that the two forms of the crayfish are alternating periods in the life of the individual, the "first form" being assumed during the pairing-season, the "second form" during the intervals between the pairing-seasons. It is to be inferred that before the animal is again capable of reproduction another moult will bring it again into the "first form."

The fact that large collections, made at one time and place, often contain only one or a great preponderance of one form of the male is now explained.

I have also before me a male specimen of *Cambarus propinquus*, Girard, from Wisconsin, belonging to the Peabody Museum of Yale College, which was taken in the act of moulting. The old shell is "first form," the soft shell emerging from it is "second form."

It is remarkable that two forms of the male have not been detected in any other genus of crayfishes.

Fritz Müller ('Für Darwin') has pointed out the existence of two forms of the male in the genera *Tanais* and *Orchestia*, which he considers as truly dimorphic forms. It is possible that these are to be explained in the same way as the two forms of the male *Cambarus*.

Such a change as this connected with the reproductive period is unparalleled, so far as I know, among the Invertebrata, and even among the Vertebrata; the cases of partial atrophy of the generative organs or shedding of antlers (as in the stag) after the rut is over are hardly comparable.

At the time I had the specimens alive my attention had not been drawn to the questions relating to the two forms of the males, so that I failed to make anatomical examination, and the specimens have now lain too long in alcohol to be serviceable for internal dissection. I hope, however, that naturalists who are more favourably situated will be able to throw more light on this subject.

I will add that the males of extraordinary size which I have seen are all of the "first form." Do these very old individuals cease to moult? Do they become permanently capable of reproduction?—*Amer. Journ. Sci.*, January 1884, p. 42.

Museum of Comparative Zoology,
Cambridge, Mass.,
Nov. 12, 1883.

On Visual Organs in Solen. By Dr. B. Sharpe.

Dr. Benjamin Sharpe called attention to a remarkably primitive form of visual organ that he had discovered in the siphon of *Solen ensis* and *S. vagina* (the common "razor-shell").

His attention was directed to the probable possession of visual organs by observing a number of these animals which were exposed in large basins for sale at Naples. A shadow cast by his hand caused the extended siphons of the specimens on which the shadow fell, instantly to retract, while those not in the shadow remained extended. Repeating this experiment at the Zoological Station at Naples, and being fully convinced that the retraction was due to the shadow and not to a slight jar which might have been the cause, he was led to examine the siphon more closely, and he also made a series of vertical sections for the purpose of very minute study.

When the siphon of a large *Solen* is cut open and examined, a number of fine blackish-brown lines or fine grooves are seen. These are situated between and at the base of the short tentacular processes of the external edge of the siphon. As many as fifty of these little grooves were found to be present in some specimens, and some of them were from 1 to 1·5 millim. in length.

When a vertical section is examined these pigmented grooves are distinctly seen, and the cells of which they are composed are very different from the ordinary epithelial cells which cover the more pigmented parts. These latter cells are ordinary columnar epithelial cells with a large nucleus which is situated near the *tunica* on which it rests. The pigmented cells are from one third to one half longer than those just described, and consist of three distinct parts. The upper part, or that part furthest from the *tunica*, appears perfectly transparent and takes up about one ninth or one tenth of the total length of the cell; this part is not at all affected with the colouring-matter used in colouring the whole. The second part of the cell is deeply pigmented and consequently opaque; it is filled with a dark brown or almost black granulated pigment; this takes up about one half of the length of the cell. Below this is the third part of this cell, consisting of a clear mass, which takes a slight tinge when coloured; this is probably the most active part of the cell; in this is imbedded the large oval nucleus. This nucleus is sharply demarcated and is filled with a granulated matter, which takes a dark colour in borax carmine, as do, indeed, the nuclei of all the epidermal cells.

These *retinal cells*, if they may be so called, are similar to those described by P. Fraisse in 1881 (Zeitschr. f. wiss. Zool., Bd. xxv.), in the very primitive eye of *Patella cærulea*, the principal difference being that in *Patella* the transparent part at the top of the cell seems to be a little more extensive. This eye of *Patella* is open, being merely an invaginated part of the epidermis, and has no lens. In *Haliotis tuberculata* we find an open eye also, but with the addition of a very primitive lens. The next higher grade of eye seems to be that of *Fissurella rosea*, in which the eye is closed and possesses also a lens; now in these two latter forms, where we find a lens present, the retinal cells do not possess the transparent ends we find in *Patella* and *Solen*, but the pigment fills the upper part of the cell quite to the top. This would indicate, he thinks, that the transparent part took the place of a lens.

No special nerve-fibres could be detected passing to these pigmented grooves. Nerves passing to the eye of *Patella* were also wanting; while, on the other hand, distinct veins were found passing to the eye of *Haliotis* and *Fissurella.*

He further stated that this power of distinguishing a shadow would be of great use to the animal in the struggle for existence. The *Solen* lies buried perpendicularly in the sand, and allows the siphon to project a little above the surface. This projecting part would, probably, frequently be bitten off by fishes, were it not for the fact that the shadow of the enemy would give warning, so that the siphon could be withdrawn in time to save it from destruction. —*Proc. Acad. Nat. Sci. Philad.*, Nov. 6, 1883, p. 248.

On a Nematode Parasitic on the Common Onion. By M. Joannes Chatin.

It is well known that the parasitism of the Nematoda is exerted not only at the expense of animals, a certain number of these worms attacking various plants, in which they give rise to more or less serious alterations. The Anguillula of mildewed wheat has been very long known; an allied species, parasitic on the coffee-tree, has been studied by M. C. Jobert; and other worms belonging to the same group are observed in Dipsaceæ, Mosses, &c., as I took occasion to state in a communication dating some years back.

The worm which forms the subject of the present note lives as a parasite in the common onion (*Allium Cepa*, Linn.), and becomes in it the cause of a disease of which I have been able to trace the different phases, thanks to the extreme kindness of M. Pasteur, who sent me, in May 1881, a portion of a bulb infested by these Nematodes. I have been compelled to defer the publication of the results of my researches on account of the time necessary for tracing the development and the mode of propagation of the worm, appreciating exactly its vital resistance &c. Even now I shall confine myself to a summary of the principal points of its history; the anatomical and embryogenic details &c. must find a place in a more extended work.

By its general characters and especially the construction of its digestive tube, as also by the organization of its reproductive apparatus, the Anguillula of the onion must be classed in the great genus *Tylenchus*, and every thing authorizes our thinking that it represents a species distinct from those which have hitherto been described.

It is in the larval state that the worm penetrates into the bulb, which it attacks at the level of the "fundamental axis;" then it spreads into the roots and to the base of the flowering stem, generally respecting the external tissues, but completely disorganizing the central tissue, even getting into the fibro-vascular bundles and reducing them to a brownish pultaceous mass, in which nothing but a few fragments of spiral vessels is soon to be observed.

The Anguillula then attains its full development, the sexual organs, sketched out in the larva, rapidly complete their formation; fecundation takes place; and from the ova issue the young claviform larvæ, which are speedily set free by the disaggregation of the bulb. They creep about in the surrounding soil, that is, if the latter is sufficiently damp; in the contrary case they remain dried up and in a state of latent vitality, until the moment when favourable conditions permit them to revert to active life. On arriving in the neighbourhood of a normally developed *Allium* they penetrate into it, as above stated, and the cycle recommences.

In this way is explained how the same bulb contains at the same time adults, ova, and larvæ, and also how the parasite can be transmitted with the greatest facility from one plant to another, and how it is rapidly propagated through a whole plantation. As to the propagation through the floral organs &c., this is rare, the Anguillula only attaining them with difficulty, and this, indeed, precisely on account of the initial injuries which it causes in the bulb, and the effect of which is to arrest the development of the flowering-stem or to dry it up quickly.

The larvæ present a faculty of revivification analogous to that observed in the larvæ of the Anguillula of mildewed wheat; but it would seem that here this faculty is less powerful. I have, however, been able to ascertain it in larvæ preserved for twenty-six months in a dry well-corked bottle; beyond this period I have only obtained negative results. The adult Anguillulæ, subjected to desiccation, perish quickly, as is also the case when they are exposed to a cold of $-10°$ ($=14°$ F.), which has no action on the larvæ. Acidulated water and dilute alcohol instantly kill the adults, while the larvæ retain their vitality in them for some time.

These facts are obviously comparable to those observed in the case of the Anguillula of mildewed wheat, but the onion-parasite constantly manifests a smaller vital resistance. There is only one exception to be made in this particular:—M. Davaine has shown that the Anguillula of the mildewed wheat when introduced into the digestive canal of fishes, batrachians, and reptiles remains intact, whereas if the experiment be repeated with birds or Mammalia the worm is soon digested. Now the Anguillula of the onion does not undergo any alteration in this same medium, and is to be met with again, distinctly characterized, either in the dejections or in the contents of the intestine, if the animal has been killed shortly after the ingestion of portions of the plants containing the worms. One might thus be exposed to the error of regarding them as true parasites of the host into which they have been accidentally introduced, and in which they cannot acquire any development or undergo any encystation, as I have clearly ascertained.

The agents employed against the Anguillula of mildewed wheat may be used against the parasite of the onion; but the most efficacious process consists in pulling up the diseased plants and burning them.—*Comptes Rendus*, December 24, 1883, p. 1503.

Evidence of a Protozoëa Stage in Crab Development.
By H. W. Conn*.

There is great interest attached to speculations as to the probable ancestry of the Decapods, owing to the value which the conclusions have in enabling us to interpret palæontological facts. There have been quite a number of theories advanced as to the original stem from which the Decapods have been derived, two of which claim especial attention. One is the theory of Müller, who finds such a stem-form in the zoëa. Another, suggested by Claus, or in a different form by Brooks, considers the protozoëa as the ancestral stem. It is of great importance in understanding the Crustacea to decide between these two views, inasmuch as by the first view Crustacea are supposed to have descended from a form without a thorax, while according to the second, the thorax was present in the original Decapod stem. Some work done at Hampton during the last summer upon the larval cuticle of crabs indicates conclusively that the latter view is the correct one, or that at least Fritz Müller's view is incorrect. The larval skin, particularly the telson, of a large number of crab zoëas was studied with the following results:—The larval skin is not in different crabs alike, nor is it in any case exactly similar to the enclosed zoëa. There is always an indication, more or less complete, of some previously existing stage. There has been shown in the various forms studied a gradation from the larval skin, with little difference from the zoëa enclosed, to a larval skin which is utterly unlike the zoëa, but which possesses a forked tail with fourteen long feathered spines. This gradation is complete, and a study of the different embryonic telsons shows that all have been derived from the form shown by *Panopeus*, which has a forked tail with fourteen spines. Now such a larval skin is to be considered simply as the cast-off skin of some stage immediately preceding the zoëa. It has been shown by Paul Meyer that the study of the larval skin of Macrura leads to a similar result; that a forked tail with fourteen spines is also seen in the early history of this group. If therefore a form can be found which shows these peculiarities, we have reason for accepting it as the stem-form of the higher Crustacea. Now a study of the different protozoëa-forms which occur in the ontogeny of various Macrura shows that we have in this form a stage which fulfils the conditions. It has the forked tail with fourteen spines, and has large swimming antennæ, another peculiar characteristic of the crab larval cuticle. If the various larval skins of crabs and Macrura be compared with each other, it will be seen that they are all to be considered as modifications of a tail much like that present in the larval skin of *Panopeus*; and if this tail be compared with the protozoëa-tail of *Peneus*, the likeness will be seen to be very striking. We have therefore, in the comparative study of the larval cuticle of crabs, good reason for accepting as the stem-form of the Decapods a form which had resemblance to a protozoëa.—*Johns Hopkins University Circulars*, Jan. 1884, p. 41.

* Abstract of a communication to the University Scientific Association, November 7, 1883.

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XVIII.—*On* Grantia ciliata, *var.* spinispiculum, *Crtr.* By H. J. Carter, F.R.S. &c.

[Plate VIII.]

Having lately (September 1883) had occasion to collect a few of the Calcispongiæ which grow upon the rocks and seaweed about this place (Budleigh-Salterton, South Devon), I found it necessary to refer to Dr. Bowerbank's 'Monograph of the British Spongiadæ' to ascertain if I had among them any specimens of the *Grantia ciliata* illustrated in his third vol. (pl. ii. figs. 1–15), which appears to me to be typically that described and illustrated by Dr. Johnston in his 'History of British Sponges' (p. 176, pl. xx. fig. 4, and pl. xxi. figs. 6 and 7). Of this the type specimen is in the Johnstonian collection in the British Museum (no. 30, registered 47. 9. 7. 79), evidencing Montagu's remark respecting this sponge, which Johnston has quoted, viz. "that the specific character of being 'surrounded at top by a crown of spines' is rarely identified" (*op. et loc. cit.*). This is also shown in Dr. Bowerbank's illustration (*op. et loc. cit.* pl. ii. figs. 1 and 3); but in his description of this species (*op. cit.* vol. ii. p. 24) he refers for further particulars to his first paper on "The Organization of *Grantia ciliata*," viz. that in the 'Transactions of the Microscopical Society' (vol. vii. p. 79, pl. v.), where the illustrations of the *entire* sponge (figs. 1 and 2) are quite different from those in the third volume of his 'Monograph.'

These differences were observed by Häckel in 1870, when he made two species of them under the name of *Sycandra ciliata* for the former and *S. coronata* for the latter ('Die Kalkschwämme,' vol. ii. pp. 296 and 304, and 'Atlas,' Taf. li. and lviii. and Taf. li. and lx.). But it does not seem to have influenced Dr Bowerbank in 1874, although the Rev. A. M. Norman, who edited the posthumous volume of his work (vol. iv., 1882), adopts the separation (p. 230).

However, after carefully reading and comparing Häckel's description of *Sycandra* (*Grantia*) *ciliata*, *S. coronata*, and *S. raphanus* respectively (vol. ii. p. 296 *et seq.*), together with the specimens of the two former found here, it appears to me that they run into each other in such a way that, although there may be grounds for making a separate species of the latter, I, with the late Dr. Bowerbank, see none for separating specifically the two former. The differences that exist between *Sycandra ciliata* and *S. coronata* appear to me to arise chiefly from the circumstances under which they have grown, viz. whether this has taken place in strong currents or comparatively still water, which, on account of the extreme brittleness and delicacy of the finer and longer spicules on the surface of the body, leads to their being more or less broken off. If these spicules have been retained entire, they are generally so matted together in the dried specimen as to obscure the conuli from which they proceed and thus give the surface of the body a shaggy ("zottig," H.) character; while those of the peristome or mouth may be more or less worn away, thus corresponding with Johnston's type specimen, Dr. Bowerbank's illustrations (vol. iii. *l. c.*), and my own experience here; but if, on the other hand, the finer and longer spicules of the conuli have been broken off, while the shorter and stouter ones which succeed them inwards remain, which is generally the case, then the conuli will of course be exposed, and the peristome remaining intact, we shall get a specimen like that represented by Dr. Bowerbank in the 'Transactions of the Microscopical Society' (*l. c.*), the former being Häckel's *Sycandra ciliata* and the latter his *S. coronata*. As to specific differences being deduced from the measurements of spicules and even the entire forms themselves of sponges, these are so variable generally that it is only here and there that they afford any trustworthy evidence.

But there is a difference in structure between *Sycandra* *ciliata* and *S. coronata* on the one hand and *S. raphanus* on the other, which may, if constant, claim specific distinction for the latter; I allude to the prismatic form of the radial chambers in *S. raphanus*, whose transverse section made longitudinally to the body, midway between the surface of the cloaca and the conuli, presents a *hexagonal* arrangement with triangular spaces between the hexagons, first noticed by Häckel in his synoptical table of these sponges (*op. cit.* vol. ii. p. 294), while in *Sycandra ciliata* and *S. coronata* a similar section shows the chambers to be *circular* or cylindrical. How far this is sufficiently persistent to justify specific separation I am not prepared to state.

Carefully comparing Häckel's description of *Sycandra raphanus* with the species that prevails here, which in all respects agrees with that from the north of Shetland which I have named "*Grantia ciliata*, var. *spinispiculum*" ("Sponges dredged on board H.M.S. 'Porcupine,'" 'Annals,' 1876, vol. xviii. p. 468, pl. xii. figs. 6 and 7), I can see no difference between the two except in the presence of the spiniferous spicules in the latter, to which I shall presently allude, but which Häckel does not notice *at all* either in his descriptions or illustrations, although F. E. Schulze a few years later illustrated and described them particularly in *Sycandra raphanus* (Zeitschrift f. wiss. Zoologie, 1875, Bd. xxv. 3es Suppl. pp. 254 and 255, Taf. xix. fig. 1, *a–d*).

Now the fact of such spinous spicules having been found in *Sycandra raphanus* compared with their presence here in *Grantia spinispiculum*, whose structure otherwise corresponds exactly with Häckel's description of the former, leads me to infer that *Grantia spinispiculum* and *Sycandra raphanus* are the same, while the prismatic form of their radial chambers (and, perhaps, the spiniferous spicules) alone distinguishes them from *Sycandra ciliata* and *S. coronata.* It is the identity or not of the two former which I wish to be confirmed, as I do not possess a type specimen of *Sycandra raphanus* from the Adriatic for comparison; and therefore shall give hereafter an illustrated description of *Grantia ciliata*, var. *spinispiculum*, in all its principal detail, not only for this purpose, but to illustrate the variety itself, which hitherto has not been done.

In alluding to the acerate spicules which form the outer layer of the "collar-ring" noticed by Lieberkühn in "*Grantia ciliata* sive *Sycon ciliatum*" (Archiv f. Anat. u. Physiologie, July 1859, Heft iii. p. 373), and subsequently by Bowerbank (Trans. Microscop. Soc. *l. c.* p. 82), Häckel observes (*op. cit.* vol. ii. p. 308) that they are not to be found in *Grantia* *ciliata* ("bei *S. ciliata* fehlen"), which I fancy must be a mistake, as from microscopical examination of specimens now before me I must agree with Lieberkühn and Bowerbank in affirming that the collar-ring ("Halsring," H.) in all three (that is including *S. raphanus*) commences where the conuli on the surface *outside*, and therefore the oscules of the radial chambers on the surface of the cloaca *inside*, cease and ends where the corona proper or circle of long, straight, setaceous, simple spicules commences (Pl. VIII. fig. 2, *h*), and that this layer of comparatively thick acerate spicules externally may be more or less present, according to the wear and tear above noticed to which the specimens may have been subjected. How far we may be justified in identifying with *Sycandra raphanus* the specimens of *Grantia ciliata*, var. *spinispiculum*, which I have lately found here, the following illustrated description, as above suggested, may determine.

Grantia ciliata, var. *spinispiculum*. (Pl. VIII. figs. 1–8.)

Pyriform elongated, fixed by the small end to the object on which it may be growing, terminated at the large or free end by an asbestine glistening pencil of long straight spicules; conulated over the surface, which is also ciliated with fine long spicules, inclined forwards and often presenting an asbestine sheen, like that of the pencil of spicules at the free end; more or less inflated and bent upon itself, often dividing into two heads, that is bigeminate (Pl. VIII. figs. 1 and 2). Colourless or transparent white. Consistence fragile. Surface uniformly covered with conical processes in juxtaposition (fig. 2, *a a a*), whose framework is composed of triradiate spicules, terminating towards the point of the cone in a slightly extended ray, which, intermingling with a bunch of linear spicules consisting of *fifty or more* of variable length, altogether forms the ciliary covering of the body just mentioned. "Bunch of linear spicules" composed of six forms, viz.:—1, extremely slender, almost immeasurably thin, straight, smooth, almost imperceptibly tapering outwards from an equally slight enlargement of the proximal end, in shape something like knitting-needles ("Stricknadeln," H.), in bundles scantily dispersed among the larger acerates, variable in length, averaging perhaps about 1-85th inch long, but seldom found entire from their delicacy. 2, short, fusiform, slightly curved and spined over one or both sides of the distal portion, which is terminated by a short smooth spur turned in the opposite direction, varying in length about 1-461st of an inch, which is that of the shortest observed (fig. 3, *c*). 3, short straight acerates, minutely spined or serrated also over their distal portion, sharp-pointed, or terminated by a pin-like inflation at the distal end; shortest form seen about 1-300th of an inch (fig. 4, *c* and *d*). 4, long, straight, smooth, slightly tapering from a more or less slightly enlarged lanceolate or simply pointed proximal end to a curved free extremity, about 1-300th inch in length, serrated over the convexity and ending in a sharp smooth spineless point, which is turned in the opposite direction; serratures more or less distinct and in many instances evidently directed *outwards*, diminishing in size towards either extremity, the whole spicule varying in length from 1-461st of an inch, which is that of the smallest above mentioned, to 1-6th inch, which may be the maximum length of the longest (fig. 3). 5, like the last in form, but *straight throughout*, terminating in a very fine point, serrated on one side only, in two approximated broken lines, for about the same length as the foregoing, but with the teeth much larger and directed *inwards*, diminishing in size to the distal extremity as they increase in size in the opposite direction; length variable, viz. from about 1-300th of an inch, which is that of no. 3 above mentioned, to 1-23rd inch, which is the maximum of that observed (fig. 4). 6, gently curved once or twice, variable in length, but much shorter than the foregoing; smooth and pointed in the inner or proximal portion, serrated and abruptly or capitately terminated at the other; teeth as in the foregoing, on one side only, *recurved* and arranged in two approximated broken lines extending backwards for about 1-333rd inch from a slightly inflated head with 0–3 spines, directed *backwards* like the anchoring-spicule of *Euplectella*; length of longest observed about 1-36th inch (fig. 5). All these forms in *front* of the *stem* are directed forwards, and in all not only is the length very variable, as may be seen from the measurements above given, but the serration or spination and general form also are much modified, especially in the smaller kinds (nos. 2 and 3), while in the larger and longer (nos. 4 and 5) they are more persistent; and while no. 4 prevails towards the larger end of the body, the more distinctly spined or toothed spicules, nos. 5 and 6, together with 2 and 3, prevail towards the root. Peristome, vent, or mouth, as it has unfortunately been termed, composed of two portions, viz. a "neck" or "collar" (fig. 2, *h*) and a "crown" (fig. 2, *g*), the "collar" consisting of a contracted portion of the body about 1-60th inch in longitudinal diameter, naked or uncovered by the conuli, which do not extend further forward than this point, and thus the distinction is clearly defined; composed outside of a layer of stout, smooth, slightly curved, fusiform, sharp-pointed acerates, about as long as the collar is broad (fig. 2, *h*), arranged longitudinally side by side, with their convexities inwards, and supported inside by a layer of tri- and quadriradiate spicules continuous with that of the surface of the cloaca, and equally armed by the projecting spur of the quadriradiate, although of course deficient in the holes of the radial chambers, which cease at the commencement of the structure externally and internally. "Crown" consisting of a circular row of long, straight, smooth, almost cylindrical spicules, about 1-18th inch in length, arranged longitudinally side by side, tapering slightly towards their free extremities from an equally slightly enlarged and pointed end which penetrates for some distance the distal margin of the collar, and on issuing thus forms a fringe or pencil of setaceous spicules that, when together, present the asbestine sheen above noticed, and, finally, may be expanded or approximated as required. Internal or body-structure (fig. 2, *e e*) composed of radiating prismatic chambers in juxtaposition, which extend transversely from the conuli that form their extremities on the surface to that of the plane of the cloaca internally (fig. 2, *f f*), supported throughout by the interlacing of tri- and quadriradiate spicules, which are so disposed in their course as to present a hexagonal form separated by small triangular interspaces externally (fig. 2, *d d*), and on the surface of the cloaca, so as to leave a number of holes corresponding in regularity to the chambers of the body (fig. 2, *m*), each of which is provided with a sphinctral diaphragm of sarcode just inside the margin (fig. 6, *b*). Stem (fig. 2, *i*) very variable in length, often obsolete, composed of a solid cylindrical mass of the tri-, quadriradiate, and linear spicules above mentioned, extending from the bottom of the cloaca to the object on which the sponge may be growing, and, of course, as destitute of the conuli and the radial chambers as the collar of the peristome. Root (fig. 2, *k*) presenting a group of tri- and quadriradiate spicules, from each of which an arm of variable length, below 1-60th of an inch, is considerably extended backwards and longitudinally, tapering at first and then ending in a more or less inflated lanciform extremity; surrounded by a fringe of short and long spiniferous or toothed spicules recurved or directed backwards, such as have been described under nos. 3, 5, and 6, most of which, but especially the latter (whose proximal ends are more or less lanceolately inflated, their length greater, and their teeth larger than those about the body), have their extremities fixed in their own or the indurated sarcode of some other neighbouring organism, which adheres to the rock (fig. 8) and thus forms the "root" or final bond of attachment. Pores in the spaces between the conuli on the surface (fig. 7, *b*). Excretory canal-system consisting of the radial chambers, which have been described before as opening into the cloaca through sphinctered apertures (fig. 6, *a b*), and the cloaca itself, which, occupying the centre of the body, consists of a cylindrical cavity corresponding in shape with the specimen, that is, narrow behind and wide in front, commencing in a blind point close to the stem, and ending in a wide mouth at the collar (fig. 2, *l l l*); surfaced uniformly with circular holes, which are the oscular vents of the radial chambers above mentioned, arranged with corresponding regularity (fig. 2, *m*), and would be in juxtaposition but for the intervention of the spicular structure of the body, from which projects the fourth arm of the cloacal quadriradiates that are curved and directed forwards (fig. 2, *n*); limited in front by a sarcodic sphincter which separates the collar from the cavity of the cloaca. Size of specimen variable according to age and situation; average of that above described, which grows a little below high-water mark on the rocks here (fig. 1), about 4-12ths inch long by 1-12th inch in its broadest part, not including the lateral spicules, which, as above stated, vary under 1-6th inch in length.

Hab. Marine. On *Fuci* near low-water mark, or abundant on the under surface of New Red Sandstone rocks a little below high-water mark. In company with an equal abundance of the following Calcispongiæ, viz. *Grantia clathrus*, *G. compressa*, *Leuconia Johnstonii*, *L. fistulosa*, and *Leucogypsia Gossei*, together with the common littoral siliceous sponges *Halichondria panicea* and *H. sanguinea*.

Loc. Budleigh-Salterton, south coast of Devon.

Obs. It is evident that a longitudinal section of the body across the radial chambers of this variety shows, as Häckel has stated respecting *Sycandra raphanus* (*op. et loc. cit.*), that its chambers are "hexagonal" in contradistinction to those of *Grantia* (*Sycandra*) *ciliata* and *G.* (*S.*) *coronata*, which are circular; but, as before stated, what these differences may amount to from a specific point of view, as they may easily graduate into each other under the circumstances, I am not prepared to say; nor am I able to state how far the longer spicules with spinous extremities may be absent in these two forms, as Häckel does not mention any, and my own specimens, which are all *dry*, fail to show them; for they are either broken off or so inextricably clotted together by hardened sarcode as to defy all attempts at disassociation; but the spines certainly do not appear on the shorter linear ones of the cone specimens which remain in these, while they do so on most of the shorter linear ones of *Grantia spinispiculum*, although even here there may be an admixture of both kinds. At the same time long, stout, terminally curved spicules of a similar form, but *smooth throughout* (that is, without spines and not so much bent at the ends), may be more or less plentiful in the conular "bunches" of *Grantia ciliata* and *G. coronata*; wherein the chief differences between these and those of the variety *G. spinispiculum* appear to me to consist.

The capability of entirely closing the cloaca, which is essentially the "rectum" or termination of the excretory canal-systems in *all* hollow sponges, whether calcareous or siliceous, by the extension of a sarcodic, sphinctral diaphragm across the mouth at the junction of the body with the collar-ring, first noticed by Bowerbank in *Grantia ciliata* (Trans. Micros. Soc. 1859, vol. vii. p. 83), although not so plainly seen as that provided for the opening of each radial chamber into the cloaca, together with the relationship of the ends of the cones, which, although closed in the dried state by a kind of spiral twist of the linear spicules ("monoceles," H.) around their apices, respectively, would appear to have an opening here in the living one, is a mechanism which I cannot understand, seeing that the inhalent channels which lead to the chambers are on their outer side, as distinctly indicated by the pores themselves in the triangular interspaces between the conuli on the surface (Pl. VIII. fig. 7). That the single tubular vent projected from the young *Spongilla* when grown from the statoblast does close up for a time after a surfeit of *carmine*, I have long since witnessed and described ('Annals,' 1857, vol. xx. p. 30, pl. i. fig. 1); and if the sphinctral membrane at the base of the collar-ring acts in connexion with the conuli and sphinctral diaphragms of the radial chambers in *Grantia ciliata* and its varieties, they being all parts of the *excretory* canal-system, then the same kind of general closure may take place as in the young *Spongilla* under similar or other circumstances.

To attempt to describe all the varieties of form in the spicules of the sponge would be vain, from their great number, hence they can be only learned by a practical examination. To assign the use of the spined spicules too would appear to be wholly conjectural from their almost general distribution over the whole surface of the body, had we not a parallel case in the young spherical *Geodia* &c., wherein the anchoring-spicules ("anchors" and "forks") are developed over the whole of the surface, but for the most part only retained in a *projected* state where the *Geodia* is nearest to the object to which it may be attached, when they come into use for anchoring-purposes, while those in the more exposed parts are more or less broken off. Such appears to be the case in *Grantia ciliata*, var. *spinispiculum*. The capitate spiniferous or denticulated spicules (Pl. VIII. fig. 5) would appear to be particularly adapted for this purpose; but they are by no means so numerous as the pointed ones (fig. 4), neither are they a bit more confined to the root, while the *capitate* portion itself appears to arise from a modification of the end of the spiniferous portion of fig. 4, in which the substance of the latter becomes retracted into an inflation, which may be simply round ('Annals,' 1876, vol. xviii. pl. xii. fig. 8), or provided with two or three recurved spines like that of the anchoring-spicule of *Euplectella*, as above stated. Hence I cannot agree with Schulze (Zeitschrift f. wiss. Zool. Bd. xxv. 3es Suppl. p. 255) in deriving this from a quadriradiate spicule.

The hardy nature of the Calcispongiæ, which are so much more fragile and delicate in structure than the siliceous sponges, is very remarkable here, where the roof of the cavern in the New Red Sandstone rock at "Straight Point" is just now absolutely covered with a mixture of all the species above mentioned, together with the siliceous species, viz. *Halichondria panicea* and *H. sanguinea*, Johnst., although it is only a few feet below high-water mark, and must be wholly uncovered by the sea for several hours twice a day, during which, of course, the sponges are kept wet by the dripping from the rock of the sea-water, which has also twice a day been absorbed during the time that it has been under water. Thus, high-water mark is not less characterized by the well-known littoral siliceous species with linear, than calcareous sponges with triradiate spicules.

I would here remark that to examine satisfactorily *Grantia ciliata*, var. *spinispiculum*, great delicacy of manipulation is required, otherwise most of the long spicules will inevitably be broken off, if they have not already suffered much in this way by the waves in their natural element. Thus it will be found advisable to bring away a portion of the rock on which they are growing and place it in spirit then or afterwards, to examine this carefully *under water* at home, to raise the root with a spatuliform needle most carefully, and to transfer to a slide for microscopical examination or subsequent mounting in balsam (N.B. which does not show an acid reaction with test-paper) the parts that are required, by means of capillary attraction, through a pipette. In this way the spiculation may be seen *in situ*; but when the *entire* spicules of different parts are required, then such portions of the body as might yield them are to be boiled separately, in *liquor potassæ*, until they become disintegrated; the liquor poured off and the residuum in the watch-glass washed *twice only* with pure water, most carefully draining throughout, lest the minute spicules be carried away by the edulcoration; then the last drop containing the spicules should be transferred to a glass slide and drained again, but *not to perfect dryness*; now add one or two drops of glycerine, and secure the whole under a large glass cover, finally adding a little balsam at the cardinal points to keep it from slipping. This process has the advantage of preserving all the spicules, small and great, and, from their not having been reduced to absolute dryness, of preventing that crystallization of the remaining potash around them which otherwise would inevitably obscure their forms, while it yields a preparation which can be recurred to for deliberate examination as long as it may be required.

P.S.—A delicate spiniferous spicule, to which attention has not hitherto been directed, exists all over the surface of *Leucogypsia Gossei*, often fringing the mouth too in the manner of a peristome. It is fusiform, slightly curved, and spined proximally, chiefly over one side only, while the free extremity is armed, bayonet-like, with a short, delicate, smooth, slightly curved spur.

EXPLANATION OF PLATE VIII.

Note.—The representations in this Plate must (with the exception of fig. 1, which is of the natural size) be regarded as diagrams drawn to scale, that the reader may be able to realize as far as possible the relative proportions of the different parts of which fig. 1 is composed. Thus fig. 2 has been drawn to the scale of about 1-96th to 1-1800th inch, and even here the scale is not sufficiently large to show the spines on the spicules; so these, viz. 3, 4, and 5, have been drawn to the scale of 1-24th to 1-6000th inch; while for perspicuity also figs. 6 and 7 are magnified to double the size of the same parts in fig. 2.

Fig. 1. *Grantia ciliata*, var. *spinispiculum*, Crtr., single and double. Natural size.

Fig. 2. The same. *a a a*, body; *b*, peristome and collar; *c*, stem and root; *d d*, cones on the surface, direct view; *e e*, the same, lateral view, showing their connexion with *f f*, the radial chambers; *g*, peristome; *h*, collar; *i*, stem; *k*, root; *l l l*, dotted line showing the form of the internal cavity or cloaca; *m*, openings of the radial chambers into the cloaca; *n*, projection of the fourth ray of the quadriradiates of the cloaca into that cavity.

Fig. 3. The same. Spined spicule of the cone with *curved* free extremity, about 1-13th inch long. *a*, inflated, smooth, or proximal end; *b*, curved, serrated or distal end; *c*, shortest form seen, about 1-461st of an inch. Teeth directed *outwards*.

Fig. 4. The same. Spined spicule of the cone and root, with a *straight* free extremity, about 1-23rd inch long. *a*, inflated, smooth, or proximal end; *b*, straight, toothed, or distal end; *c*, shortest straight specimen seen; and *d*, shortest *capitate* specimen seen, each about 1-300th inch long. Teeth directed *inwards*.

Fig. 5. The same. Capitate spined spicule of the cone and root, about 1-36th inch long. *a*, smooth, sharp-pointed, or proximal end; *b*, spined and capitate or distal end. Teeth recurved.

Fig. 6. The same. Diagram of four radial-chamber vents, to show the sarcodic sphincters in them respectively. *a*, vent; *b*, sarcodic sphincter.

Fig. 7. The same. Diagram of seven cones, to show the position of the pores in the triangular spaces between them. *a*, cone; *b*, pore.

Fig. 8. Sand-grains of the rock on which the variety has grown.

XIX.—*Some Preliminary Remarks on the Gemmules of the Freshwater Sponges.* By Dr. William Marshall *.

The gemmules of the freshwater sponges, as is well known, present in the constitution of their envelopes a series of very remarkable peculiarities, which are very different according to the species, and which, as adaptations, must have very special causes and significations.

Each germ possesses, according to the species, a round or oval, sometimes convexo-concave shell, furnished with one opening, or (in *Spongilla multiforis*, Cart.) with one principal and several subordinate apertures, through which the mature contents issue at the proper time. The innermost layer of this shell is a firm structureless membrane, which Carter † describes as chitinous ("*chitinous coat*"), by which, no doubt, is meant only that it is "horny," without reference to its chemical constitution.

In some few kinds of gemmules this innermost simple thin layer is alone present; in others the wall is thicker, and appears sometimes very peculiarly modified. Thus in *Spongilla nitens* (according to Carter's ‡ and my own observations) and in *S. Carteri* (according to Carter) we see that the thick capsule is not homogeneous, nor does it show that constitution which Carter calls "granular cell-structure." Under a low power it appears in section to be finely striated radially, and its surface, like that of the eye of an insect, appears divided up into elegant convex equilateral hexagons; by the employment of higher powers we discover that the lines of striation are not the expression of hexagonal corneous pyramids di-

* Translated by W. S. Dallas, F.L.S., from the 'Zoologischer Anzeiger,' 1883, pp. 630–634 and 648–652.

† Ann. & Mag. Nat. Hist. ser. 5, vol. vii. p. 83.

‡ *Loc. cit.*

minishing centripetally, but that they appear zigzagged and always so that in two neighbouring lines the opposite angles of the zigzag have their apices either turned towards or away from each other; and at the same time it is observed that the angles of two horny lamellæ which are turned towards one another are united by transverse floors; in other words the entire capsule of the gemmule consists of a system of little compartments inserted into each other in accordance with the three dimensions of space, and gradually diminishing in the thickness of their walls and in their dimensions from without inwards. The superficial compartments are hollow, and in the dry state, which alone we have here to take into consideration, filled with air; the innermost are solid; their form is that of a hexagonal prism terminated at each end with six faces, the longitudinal diameter of which lies tangentially to the sphere of the contents of the gemmule. These compartments are certainly not modified cells, but, like the innermost independent horny layer of the whole capsule, a cuticular formation. Their substance is structureless and very strongly refractive; it resists calcination remarkably, becomes brown without shrivelling, and during this process only the angle-lines stand forth strongly, especially of the angles of the compartments in which several walls meet together from different sides. Hydrofluoric acid has a peculiar effect upon this substance; by treatment therewith it loses its strong refractive power and also somewhat of its yellowish colour, and especially its brittleness, for which reason in gemmules treated with hydrofluoric acid we see the radial lines of contact of the compartment-columns brought much closer together, and the compartments, often enlarged in a radial direction, in general, but especially in the peripheral layers, much more irregular in form. Hence it seems to me not improbable that a strong percentage of silica is proper to this substance. Externally and internally the compartment-layer of the capsule is surrounded by a system of tangentially-placed but otherwise irregularly-arranged siliceous spicules, beset at both ends, even as far as the middle, with fine spinules curved inwards. The spicules adhere more firmly to the inner surface of the compartment-layer than to the outer surface of the firmer horny layer in immediate contact with the germ, which exhibits a fine concentric striation, and on the outside fine irregularly-placed pits, the impressions of the spinules of the inner tangential spicules. This is easily seen in sections through the gemmules, in which the inner layer readily separates from the compartment-layer.

The aperture of exit for the germ when awakened to life is round, and passes through both layers of the wall; but it is furnished with a remarkable closing-apparatus, as Carter figures it in a gemmule of *S. Carteri*, Bow. The envelope immediately surrounding the inner germ separates at one spot in such a manner as to form a globular hollow space, the outer wall of which projects somewhat beyond the outer surface of the compartment-layer, in the thickness of which the cavity is situated; therefore this alone is penetrated. If the dry gemmules be thrown into water they float with this capsule upwards, so that its surface remains out of the water. It is only after from eight to ten days that they begin to sink; and if, as is probable, this is the case also with the living gemmules, the germs will only then awaken. This closing-vesicle seems to me to be a hydrostatic apparatus; and that it maintains the gemmules so long at the surface of the water is perhaps not without significance, for if they are carried by the wind into shallow pools, which the power of the sun would soon dry up, their contents will not issue forth before the evaporation occurs, and will thus, by the delay that takes place, escape destruction.

The formation of the germ-capsule will very probably take place as follows:—the portion of the parent animal separated as a germ first of all itself secretes on its surface a horny covering in layers (whence the concentric striation) as a cuticular formation; to this is then applied from without a system of tangential spicules; and upon this again, as a cuticular formation of the parent organism, the compartment-layer, which is finally coated by the external system of tangential spicules. The germ, which, as in all *Spongillæ*, consists in the dry state for by far the greater part of starch-corpuscles (probably reserve nutritive material), as already described and figured by Carter, is in this way admirably protected, but at the same time also in other respects most advantageously endowed.

The gemmules in *S. nitens* are remarkably small (as also in *S. Carteri*), and therefore light, and all the lighter because the comparatively thick enveloping capsule contains such numerous cavities. The importance of this remarkable architecture of the capsule in my opinion lies in this, that by it the gemmules will find the widest possible distribution under the circumstances in which the stock or parent *Spongilla* appears to exist—the light capsule enclosing air-spaces acts as an aerostatic apparatus!

The *Spongillæ* in question which break up into such gemmules are inhabitants of hot countries; they will frequently be liable, under the influence of the glowing sun, to be laid dry: most of them when this happens will die away; but they live on in the parts of themselves in the protected gemmules, which precisely in these species escape very easily from the dead *Spongilla*, with which they are not in the least united. The wind will take them up, scatter them here and there over the great plains of Africa &c., and deposit them in dried-up watercourses, in which they will be found by the vivifying element at the commencement of the rainy season. This is not contradicted by the fact that others come to rest in perennial fresh waters and develop there; many will be carried far away to islands and from land to land, many will get into the sea and never fulfil their destiny; but if, out of their great number, the greater because they are so small, only a very small percentage arrives at development, the preservation of the species is thereby abundantly assured.

What a means of transport for organic substances the wind is we may learn from the works of the honoured master Ehrenberg; out of the 1200 figures which he gives of organisms obtained from samples of dust carried by the trade-winds, no fewer than 285, or, in round numbers, 24 per cent., are evidently remains of sponges; and of these 46, or, in round numbers, 4 per cent. of the whole, or nearly 16 per cent. of the sponge-fragments, are fractured or entire amphidisci of various species of *Spongillæ*.

By far the greater part of the organic remains figured by Ehrenberg are derived from fresh water: we find among them Diatomeæ still with green contents rich in chlorophyll; the marine objects, Polythalamia, sponge-spicules (some of which are of deep-water forms, such as Geodiæ and Hexactinellidæ), are probably not, as Ehrenberg supposed, recent, but originate from the Tertiary deposits of North-west Africa (Oran), which contain such an abundance of fossils. That among this dust, which therefore originates from Africa, and not, as Ehrenberg supposed, from South America, to be thrown down in Europe, there are no such large specimens as the gemmules of *Spongilla nitens* for example, proves scarcely any thing. The further the particles of dust are carried from the regions in which they were taken up, the finer will they be, and *vice versâ*. According to the weight of the objects transported a sort of sifting of the atmosphere will gradually take place!

I have experimented, certainly with the roughest apparatus, in the following manner:—a number of gemmules from specimens of *Spongilla lacustris* and *S. nitens* (from the White Nile, in the Leipzig Museum), which had already been preserved dry for many years, were further dried at a moderate heat under the same conditions for eight days; then fifty of each kind were taken and mixed together, and then placed in a little heap at one end of a perfectly flat newly polished table. Towards this little heap a very moderate horizontal current of air (the force of which, however, I had no means of measuring) was then directed by means of a pair of small hand-bellows, and this immediately caused its dispersal. This proceeding was repeated six times, and each time after the dispersion of the gemmules a pair of compasses was set in the middle of the spot where the little heap had been; its legs were gradually opened at intervals of 1 centimetre, and curves were drawn upon the table. In this way were obtained ten curved regions each of 1 centimetre broad, and in these the gemmules were counted; then the mean of the six observed cases was taken and multiplied by two, in order to bring it to a percentage for each kind of gemmule. The following was the result:—

Regions of 1 centim. broad.	1	2	3	4	5	6	7	8	9	10 and more.	Total.
Gemmules of *Sp. lacustris.*	5	9	7	17	26	16	11	7	2	..	100
Gemmules of *Sp. nitens.*	1	2	..	9	13	22	27	13	9	4	100

These experiments, I readily admit, are very rough, but they do not seem to me to be absolutely valueless: this much, at any rate, may be learned from them, that the moving power of the wind acts more powerfully upon the gemmules of *Spongilla nitens* than upon those of *S. lacustris*; and to ascertain this was the purpose of the experiments.

The gemmules of the other freshwater sponges* usually differ considerably from those of *Spongilla nitens* and *Carteri*. In no freshwater sponge known to me is the connexion of the gemmules with the rest of the body so intimate as in *Parmula Brownii*, Bow., of which I have been able to examine three specimens from the Rio Negro, most kindly presented to the Leipzig Museum by Dr. Carl Müller-Halle. Each gemmule, with its shell, is surrounded by a special capsule, which is never provided with an aperture, and which contains a very small quantity of horny substance, but is formed chiefly of naviculiform spicules, lying close together, like cobble-

* I have been unable to compare those of the genus *Tubella*, Carter, and of the remarkable new North-American forms.

stones, in such a manner that their convex sides are directed outwards. These spicules are not quite irregularly arranged; they have a tendency to radiate from certain points in a stellate arrangement, and, on close examination, for example in sections, we observe that at these points the inner surface of the capsule is in contact with the true envelope of the gemmule. The latter, in fact, is not uniformly smooth, but furnished with numerous, irregularly distributed, conical prominences, which pass to the inner surface of the exterior capsule, but are only loosely connected therewith. If the gemmules are allowed to swell up in warm water within the capsules, which is a rather long operation, it is seen that in course of time the exterior capsules are first ruptured at these points of contact. This may also occur normally when the capsule with its still living contents has again got under water; as the capsule has not, like the true gemmule-envelope, a special aperture of issue, the germ, newly awakened into life, could hardly otherwise be set free.

The true envelope of the gemmule is not thick, shows a simple granular structure, and is only covered superficially with round siliceous shields, which, on the outside, rise into short spiniform knobs and are slightly hollowed within. These shields lie so closely over the whole surface that their margins overlap; only the conical prominences are quite free from them. Their margins are imbedded in the base-substance of the envelope, while their little points are exposed. The round exit-aperture for the germ is here furnished with a closing apparatus.

The significance of this complicated investiture of the gemmules of *Parmula* is not hard to understand. The exterior capsule, as Carter has already pointed out, is composed of true skeletal elements specially modified. These naviculiform spicules exactly resemble those with which the stronger trains of spicules of the framework of the sponge are coated; the capsules usually pass into this coating, and are continuously connected with it; frequently also two or more capsules are intimately united by bridges of such spicules, as Bowerbank has already shown in his figures. It is clear that in this way the gemmules are very firmly attached to the rest of the framework; and it often happens that, when one wishes to separate such a gemmule-capsule from the dried sponge with the forceps, a portion of the adhering spicule-train of the skeleton is broken away with it. This intimate union is certainly of some importance to the gemmule, and I believe that we come upon the track of it if we consider the mode of life of the species of *Parmula*. Bates mentions that *Spongilla*

Batesii occurs upon the twigs and stems of trees which are under water during the months of the rainy season; and Carl Müller* states, from the reports of the traveller Gustav Wallis, who also met with this sponge, called in its native country "Canixi" (pron. Canischi), that the sponge appears especially to be produced where air can act upon it—that is, upon *stones which are alternately wet and dry during the rising and sinking of the stream.* By means of the spicular capsules the gemmules are firmly affixed to the dried sponge, so that they cannot fall out and perish on the dry ground; but when, in the rainy season, the rising water again reaches the sponges of the previous year, the capsules are ruptured (as may be artificially shown), and the true gemmules are set free and can become developed in the water. The armature of siliceous shields seems to prevent too great a collapse of the delicate gemmule-envelopes during desiccation; as their margins overlap the conditions are similar to those of a coat of scale-armour, which also is only compressible to a certain extent. When I removed the siliceous structures by hydrofluoric acid the envelopes became very flexible. The amphidisci of the gemmule-envelopes of the *Meyeniæ* seem to have a similar function, but a double disk would not be necessary for this purpose; this, as we shall see immediately, has been produced by another adaptation.

The gemmules of the series of forms to which *Spongilla lacustris* belongs have homogeneous membranous walls provided at the surface with projecting, often spinose, tangential or radiating spicules; hence they are certainly heavier than the gemmules of the *nitens* series, but at the same time always light enough to be able to swim in and upon the water. The superficial spicules, like the uncinate processes of many statoblasts of Bryozoa, will act as adherent organs, by which the gemmules may on occasion be anchored. This constitution of the gemmules is certainly advantageous to forms of *Spongillæ* which live in stagnant or slowly flowing water, but would be of doubtful advantage to those dwelling in brooks and rivers with strong currents; here, being continually rolled and driven along, they would have few chances of coming to rest, and a large percentage would be lost. To prevent this the gemmule would have to adopt, as it were, a check in the form of a heavier shell; and this is effected by the introduction of special siliceous elements, the amphidisci, which at the same time form a shield against the occasional shocks and contusions which are inevitable in running water,

* See 'Die Natur,' Bd. xxiii. (1870), p. 181.

especially with a stony bottom. The gemmules of the *fluviatilis*-series are heavier than those of the *lacustris*-series, as one may easily convince one's self by scattering the two upon water; the *fluviatilis*-gemmules sink much sooner than those of *lacustris*. By moving water they will be rolled along slowly, and especially at the bottom.

It would appear that the *Meyeniœ* are chiefly distributed in running waters, while the true *Spongillœ* are rather inhabitants of still water. This, of course, does not mean that the two forms are sharply separated in this respect; on the contrary, *Meyeniœ* will easily be found in stagnant water, although true *Spongillœ* are not so readily met with in strongly running water.

A form of *Meyenia*, *M. mirabilis*, from the Ohlau, near Breslau, lately made known by Dr. Wilhelm Retzer*, is interesting in more than one respect; but especially on account of its gemmules, which have a triple armature of amphidisci one above the other. I do not know the character of the Ohlau (not Ohle) and its subsidiary waters, but probably its system includes many rapid brooks, so that the gemmules of the sponges occurring in it have had to adapt themselves in this direction.

I find it not inconceivable that, in the lapse of time, *Spongillœ* (*Euspongilla*, Vejd.) may become converted into *Meyeniœ* (*Ephydatia*, Lamx., Gray) by long residence in running water, *i. e.* that their skeletal elements, and especially their gemmule-envelopes, may become modified in this direction; and that, on the other hand, by a long undisturbed sojourn in standing water, *Meyeniœ* may revert to true *Spongillœ*, by the gradual loss of the amphidisci &c. From this point of view the *Euspongilla jordanensis*, var. *druliœformis*, recently described by Vejdovsky†, acquires a heightened interest. In it we have perhaps before us a *Meyenia* in process of reversion. In the siliceous elements of the shell of the gemmule drawn by Vejdovsky, in his pl. ii. fig. 19, we have before us a series of transitions from the amphidisci (*c*) to the simple disk (*e*). Moreover, these structures are much more sparingly scattered in the membrane of the gemmule (see pl. ii. fig. 14) than in the true *Meyeniœ*. I should not be at all surprised if, in course of time, in the quiet water of the pool of the Jordan, this siliceous armature were entirely to disappear—that is, supposing that no "new blood" was introduced from with-

* W. Retzer, "Die deutschen Süsswasserschwämme," Inaug. Diss. Tübingen, 1883, p. 25, pl. ii. fig. 13.

† Abhandl. d. kön. böhm. Gesellsch. d. Wiss. 6 Folge, Bd. xii. p. 22, Taf. ii. figs. 14–19.

out, producing intercrossings by sexual reproduction. That the gemmules of the new form are considerably smaller than is usual in *Spongilla* has little or nothing to do with the matter; the gemmules of *S. lacustris* vary very considerably in size in different localities, perhaps according to the size of the piece of water inhabited by the sponges, or that of the parent animal, but I can say nothing positive as to the cause of this phenomenon.

From what is above stated, we find the gemmules of the freshwater sponges adapted in the following manners:—1. Passively locomotive with aerostatic apparatus, the flying form (of the dry season), *nitens* series; 2. Passively locomotive swimming form, with anchoring apparatus, for propulsion at the surface before the wind, *lacustris* series; 3. Swimming form, with check-apparatus for slow locomotion in running water, *fluviatilis* series; 4. Secured from desiccation by a double enclosure, adhering firmly to the body of the parent, and only arriving at development when the water, during the wet season, rises again to the level, genus *Parmula*, Cart.

Besides these there also exist freshwater sponges without gemmules:—*Lubomirskia* from Lake Baikal; the forms collected in the Congo by Dr. Pechuël-Lösche, forming a new genus, *Potamolepis*, a description of which, by myself, has lately appeared in the 'Jenaische Zeitschrift'*, and the subterranean *Spongilla stygia*, Joseph, from the Cave of Gurk, in Carniolia.

In conclusion, I repeat my previous request to all my fellow-labourers to be kind enough to aid me with material, accompanied by the most exact account of the localities (the nature of the water, whether moving or quiet, whether large or small, brook, river, old river-course, pool or lake; the nature of occasional affluences, whether exposed to desiccation, &c. It is necessary to know everything!). A great many gentlemen have most kindly complied with my former prayer, but for the solution of certain questions the material can hardly be large enough!

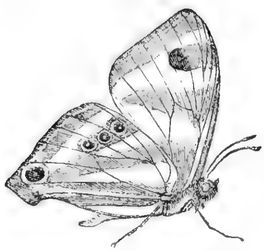
XX.—*On a new Genus of Butterfly from New Zealand.* By Arthur G. Butler, F.L.S., F.Z.S., &c.

At a meeting of the Philosophical Institute of Canterbury, New Zealand, held on the 30th November, 1883, Mr. R. W. Fereday read the "Description of a Species of Butterfly new

* See Ann. & Mag. Nat. Hist. ser. 5, vol. xii. p. 391, December 1883.

to New Zealand and probably to Science," to which he gave the name of Genus? *helmsi*; this species he referred to the Nymphalidæ, but did not venture to assign it to any group in that family.

As Mr. John D. Enys, who is now in England, has brought over the type specimen of this butterfly for my examination, with the request that I will determine its position and name the genus, I have great pleasure in doing so. The genus being a new one and greatly resembling the genus *Dodona* of Hewitson both in form and general coloration, I propose to call it



DODONIDIA, gen. nov.

This genus, as indicated by Mr. Fereday, belongs to the great family Nymphalidæ (subfamily Satyrinæ), and although it corresponds most nearly in form with *Corades* (a New-World genus), it appears to me to be more closely related to the Australian genera *Argynnina* and *Geitoneura*, from the former of which (apart from its different form) it chiefly differs in the shape of the discoidal cell of the secondaries, which is acutely pointed instead of truncated, owing to the length and obliquity of the discocellular veinlets. The body, inclusive of palpi and antennæ, corresponds closely with that of *Argynnina*; the style of coloration of the wings is most like that of *A. lathoniella*: the primaries are triangular, but with the apex and external angle obtusely rounded off; the costal margin is nearly straight, slightly incurved before the middle, and very slightly convex from apical third; the outer margin is nearly straight, rather oblique, slightly convex at apex, and incurved at external angle to meet the inner margin, which is also nearly straight; costal vein extending to apical third; subcostal five-branched, the first branch only emitted before the end of the cell, the second, third, and fourth at about equal distances beyond the cell, the fourth and fifth forming an almost equal fork to apex and outer margin; upper radial emitted from anterior angle of the cell, lower radial near to upper, so that the upper discocellular (which is inangled) is of about one third the length of the lower discocellular; the latter is slightly arched and oblique; median nervules about equidistant; submedian vein running rather near to inner margin: secondaries elongate triangular, subcaudate, and evidently internally lobed at anal angle (these wings are, however, much injured); costal margin strongly lobate close to base, so as to commence with almost a rectangle, nearly straight from the angle to the apex; outer margin slightly convex and sinuous and very oblique; abdominal margin sinuous or elongate-sigmoidal to the extremity of submedian vein, where it appears to form an obtuse angle to first median branch (but unfortunately this part of the wing is chipped away); costal vein arched, with well-defined precostal veinlet projecting into the lobate subbasal angle; subcostal branches and radial emitted at equal distances, their points of emission forming an unbroken oblique line with the lower discocellular veinlet, which is about four times the length of the upper; second and third median branches emitted slightly nearer together than the first and second. Type *D. Helmsii*, Fereday.

Dodonidia Helmsii.

Genus? helmsii, Fereday, Trans. N.-Zeal. Inst. 1883.

Paporoa Range, near Greymouth, South Island, about 1200–1500 feet (*R. Helms*). Type in Canterbury Museum.

XXI.—*Note on some Parasites of Fishes from Madras determined by Dr. Örley.* By Prof. F. Jeffrey Bell, M.A.

Brigade-Surgeon Bidie, in charge of the Government Central Museum at Madras, lately forwarded to Dr. Günther some specimens of Entozoa found parasitic in some of the bony fishes of Madras, where their prevalence, or alleged prevalence, had given rise to one of those epidemics of disquiet which are best allayed by scientific knowledge and investigation.

When the specimens in question were handed over to me I suggested, and Dr. Günther was kind enough to accede to the suggestion, that their exact determination should be entrusted to my friend Dr. Örley, of the National Museum of Buda-Pest, whose contributions to and accurate knowledge of helminthological subjects is so well known.

In the present condition of fishery problems it will be well, I think, to publish Dr. Örley's list, (*a*) as it is the first contribution to our knowledge of the parasites of Indian fishes, (*β*) as a stimulus to collectors to search for Entozoic forms, and (*γ*) as a possible source of comfort to those who are anxious as to the effects of eating fishes infested with such parasites as these.

At the foot of his list Dr. Örley says that all the parasites that were sent to him were in the cystic stage of unknown species of tapeworms; the history, however, of *Anthocephalus hippoglossi* and *A. elongatus* has been traced by no less an authority than Von Siebold, who has shown* that they are the cystic stages of *Tetrarhynchus corollatus*. Now this Cestode, when adult, lives only in the digestive tracts of rays and dog-fishes; and as we know, therefore, its two hosts we may feel confident that man may eat fishes such as *Caranx* or *Arius* without any danger of being infested with *Anthocephalus*.

So far as we are justified in arguing from the known to the unknown, we may expect that the parasites whose cystic stages are here recorded, but whose tapeworm condition has not yet been traced, will be found, likewise, to have their other host in some animal with whom the bony fishes have come for a longer time, and still come, into more frequent contact than they do with man; some shark or dogfish is, almost certainly, the second host.

On this matter, however, we must wait for the definite knowledge which is dependent on experimental investigation. This exposition of our present ignorance brings us, in the next place, to observe that, of the eight species represented in the collection, two are new to science, though Dr. Örley very properly abstains from giving a name to an immature form. A percentage of twenty-five unknown forms in a collection shows that much remains to be done before we can be said to have any thing like a fair knowledge of the Helminthology of the Indian seas. Definite knowledge of the parasites of fishes, though by no means the first, is a most important factor in the solution of those problems which are of interest and importance not only to the zoologist, but to those that catch and sell and those that buy and live on fish.

The following gives, in the third column, Dr. Örley's determinations:—

* Zeitschr. f. wiss. Zool. ii. p. 241.

Name of fish.	Region of body.	Name of parasite.
1. *Caranx*, sp.	Abdomen.	*Anthocephalus giganteus*, Dies. —— *hippoglossi vulgaris*, Bellgh.
2. ——, sp.	Œsophagus.	—— *giganteus*, Dies.
3. *Arius thalassinus* ..	do.	—— *elongatus*, Rud.
4. *Equula caballa*	do.	*Pterobothrium macrourum*, Dies.
5. *Cybium guttatum* ..	do.	—— *heteracanthum*, Dies.
6. *Synagris luteus*	do.	—— *crassicolle*, Dies.
7. *Trichiurus savala* ..	do.	—— *crassicolle*, Dies.
8. Ditto	Abdomen.	*Anthocephalus*, n. sp.
9. *Stromateus niger* ..	Œsophagus.	*Pterobothrium heteracanthum*, Dies.
10. *Sciæna*, sp.........	do.	——, n. sp.
11. ——, sp.	Intestine.	—— *crassicolle*, Dies.
12. *Drepane punctata* ..	Œsophagus.	—— *heteracanthum*, Dies.

XXII.—*The Ephyræ of* Cotylorhiza *and* Rhizostoma, *and their Development into Eight-armed Medusæ.* By C. Claus *.

During several decades various naturalists have already endeavoured to trace the development of the Mediterranean *Cotylorhiza tuberculata* (*Cephea Wagneri*, *Cassiopea borbonica*) from the egg to the Ephyra, but unfortunately with only imperfect results. Most of them † did not even get beyond the eight-armed Scyphostoma-stage. Gegenbaur ‡ alone succeeded in rearing the sixteen-armed Scyphostoma-stage, without, however, being able to bring it to strobilation and the throwing off of Ephyræ. So much, however, could be deduced with certainty from these observations, that *Cotylorhiza* does not undergo a direct development after the fashion of *Pelagia*, but passes through a Strobila-stage, the peculiarities of which were still to be ascertained. For although the known Strobilæ of *Aurelia*, *Cyanea*, and *Chrysaora* so closely repeat the same form that, without careful investigation of the tissues, we can hardly distinguish them, it is *à priori* by no means demon-

* Translated by W. S. Dallas, F.L.S., from the 'Arbeiten aus dem zoologischen Institute der Universität Wien,' &c., Bd. v. Heft ii.

† See Ecker, "Ueber die Entwicklung einer Schreibenqualle (*Cephea Wagneri*)," in 'Bericht über die Verhandlungen der naturf. Gesellsch. in Basel,' Bd. viii. 1849; W. Busch, 'Beobachtungen über Anatomie und Entwicklung einiger wirbellosen Thiere,' Berlin, 1851; A. von Frantzius, "Ueber die Jungen der *Cephea*," in Zeitschr. für wiss. Zool. Bd. iv. 1853.

‡ C. Gegenbaur, 'Zur Lehre des Generationswechsels und der Fortpflanzung der Medusen und Polypen,' Würzburg, 1854.

strated that Strobilæ differently constructed from them do not exist, especially as, in the remarkable *Stephanoscyphus mirabilis*, we know of a polyp which is comparable with the Scyphostoma, and which, in consideration of the four gastral pads, might actually be judged to be an Acalephan nurse. It is no better with our knowledge of the development of *Rhizostoma*, with regard to which the statements given by Noshin * and A. Kowalevsky † have not even settled the question whether or not a process of strobilation occurs.

Under these circumstances I was much interested in a statement in the zoological 'Jahresberichte,' according to which G. Du Plessis ‡ had recently succeeded in demonstrating in *Cotylorhiza* the occurrence of the alternation of generations characteristic of most Acalephs. However, I learned from the statement of Du Plessis just referred to, that this observer also had really not got beyond the rearing of the Scyphostomes, and that the supposed proof rests only upon very doubtful considerations. In point of fact, Du Plessis has not traced the process of strobilation, but has rather referred to *Cotylorhiza*, without satisfactory reasons, Strobilæ met with in the aquaria of the zoological station (at Naples). Moreover, they were neither fully described nor figured; and the Ephyræ thrown off by them were so insufficiently described that the existing gap is to be regarded as still unfilled. From the agreement which the Ephyra shows in coloration with the adult *Cotylorhiza* (*Cassiopea*) we can evidently not derive any data for the determination of their mutual relation any more than a general resemblance of the Ephyra to the adult *Cassiopea* can be made available for the same purpose. Such a resemblance moreover does not exist, or it is so distant that the same must apply to any other Ephyra. Should the Ephyra described by Du Plessis § really belong to *Cotylorhiza*, the description given by that author is, as we shall see, a very superficial one, for no intermediate vessels are spoken of, nor is there any mention at all of the charging of the entoderm

* N. Noshin, Bull. Acad. Imp. St. Pétersb. tome viii. (1866).

† A. Kowalevsky, "Untersuchungen über die Entwicklung der Cœlenteraten" (with eight plates), in Nachr. der Gesellsch. der Freunde der Naturerkenntniss, &c., Moscow, 1873 (in Russian).

‡ G. Du Plessis, "Remarques sur les métamorphoses de la Cassiopée borbonnière (*Cassiopea borbonica*, Dell. Ch.) faites à la Station Zoologique de Naples," Bull. Soc. Vaud. Sci. Nat. tome xvii. no. 86.

§ Du Plessis, *l. c.* p. 638:—"Du reste, ces jeunes Méduses ressemblent déjà beaucoup à la Cassiopée adulte. Elles en diffèrent seulement par une bouche quadrangulée, quatre bras simples (au lieu de huit très ramifiés) et sans suçoirs, et les bords de l'ombrelle beaucoup plus échancrés par des profondes découpures."

with zoochlorellæ, a peculiarity which immediately catches the eye as influencing the coloration and marking.

As for a long time I could not succeed, notwithstanding many endeavours, in obtaining sexually mature *Cotylorhizæ* at the period of egg-laying, and consequently in rearing Ephyræ, I attempted to get possession of them in another way, namely by pelagic fishing. For several years larvæ of *Rhizostoma* and *Cotylorhiza* were regularly captured, especially in August, which, being already in stages of more or less advanced development, could be easily determined as belonging to those two genera. I was therefore enabled some time since to publish a tolerably detailed account of the metamorphosis of these larvæ—which were already provided with intermediate marginal lobes, bifurcate buccal arms, and traces of the vascular net—into the perfect *Rhizostoma-* and *Cotylorhiza*-form*. The Ephyræ, however, were not to be obtained, and consequently an important part of the transformation, namely that of the Ephyræ into the four-armed, and of the latter into the eight-armed form, remained unknown. The circumstances through which the important peculiarity of rhizostomism is brought about and conditioned consequently were still to be ascertained. It was only in the summer of the present year that our zealous and able seaman Kossel chanced to fall in, on the 14th, 17th, and 18th July, with great swarms of *Cotylorhiza*-larvæ, in which were included all those young states which had hitherto been sought in vain.

The swarms, as Dr. E. Graeffe informs me, were driven together with masses of *Zostera* and of *Sargassum* covered with Hydroid polyparies, in the middle of the Gulf of Trieste between Barcola and the lighthouse, and must probably have been brought up by strong currents from the southern parts of the Adriatic.

Now it appeared that the same Ephyra had already once before been observed singly by me, and determined quite correctly from the nature of the entoderm, which was filled with algal cells, as probably belonging to *Cotylorhiza* †. Of course absolute certainty could only be arrived at by the demonstration of the intermediate steps to the undoubted *Cotylorhiza*, which was now furnished by the discovery of this swarm in all stages of transition. The circumstance that the entodermal coat of the gastral cavity and vascular canals was filled, although imperfectly, with zoochlorellæ, might probably indi-

* C. Claus, 'Untersuchungen über Organisation und Entwicklung der Medusen' (with twenty plates), Prague and Leipzig, pp. 43–56.

† C. Claus, *l. c.* p. 54.

cate that the older Scyphostomes, as well as the Strobila-stages, contain these vegetable cells in abundance, and grow large in definite localities which are particularly favourable to the access of those organisms. Perhaps in this we may also find the reason why no one has hitherto succeeded in bringing the bred Scyphostomes to strobilation.

The youngest Ephyra of the Mediterranean and Adriatic *Cotylorhiza* is a comparatively large form of about $1\frac{1}{2}$ to 2 millim. diameter, with eight long slender lobes, the cleft pieces or ocular lobes of which appear rounded off rather than pointed. In form and internal structure it possesses all the peculiarities of the known Ephyræ of the Semæostomean Medusæ with the exception of the Ephyropsidæ, the Ephyræ of which, as I have recently proved, exhibit important deviations both in the constitution of the gastral space and in the form of the umbrella (see Claus, *l. c.* Taf. vii. fig. 48). In its appearance our form stands between the well-described Ephyræ of *Aurelia* and *Chrysaora*, but is distinguished from both by several peculiarities which are wanting in them, and which enable it to be at once recognized and determined. The most striking of these are the numerous yellowish-brown algal cells, which partly float freely in the gastral space and partly in the radial canals, already taken up by the entoderm, giving rise to the peculiar coloration, and by their accumulation, especially at the lateral confines of the radial canals, producing two streaks in each of the main lobes. Among hundreds of Ephyræ I have not met with a specimen in which this character did not strikingly occur, and I therefore believe that these vegetable intruders perform a great, perhaps a necessary, part in the life of the *Cotylorhiza*. I will hereafter revert more particularly to these vegetable cells. Another less striking character, only observable by careful examination, consists in the presence of numerous spindle-shaped crystals in the terminal division of the ocular lobes. These crystals remind one of the chrome-yellow crystals in the ectoderm of *Nausithoë*; but they are colourless and do not border the whole margin of the lobe, but lie collected together at the surface of the lobe. They likewise originate singly in ectodermal cells. In the vascular apparatus the size of the radial intermediate vessels is remarkable, which, indeed, are entirely covered by the radial muscle, but the limits of which are still easily recognized on account of the colour of the contents. In the Ephyra of *Aurelia* these vessels scarcely appear as diverticula; while in that of *Chrysaora* they show the same considerable development. Nevertheless the latter larva cannot be confounded with ours, for it is at once recognizable by the external and internal circlets of large exumbral urticating pads, and by the rudiments of the four primary gastral filaments, which, in our larvæ, have already attained a very considerable size. The buccal tube is already characterized by the strength of its wall and the thickness of its jelly, and it is still destitute of the four arms, so that the Ephyra of *Cotylorhiza* would have to be described as "cannostomous" in Häckel's sense.

During the gradual growth the umbrellar disk of the larva constantly acquires a greater extension in comparison with the eight lobes; in other words, the distal extension of the interradii advances more rapidly than that of the radii. In Ephyræ which only slightly exceed the diameter of 2 millim. the proportion between the length of the lobe-stems and the radius of the umbrellar disk already appears distinctly altered in favour of the latter. While in the youngest Ephyræ it represented $1\frac{1}{2}:1$, the semidiameter of the disk has already attained the length of the eight lobe-stems. We may regard this larval form as a second Ephyra-stage, because on the oral part of the buccal tube new structures have made their appearance which seem to be of very great importance in the development of rhizostomism, and in combination with the strength of the wall already indicated, pave the way towards the very divergent structure of the buccal arms. Thus on the free border of the buccal tube short tentacles have grown forth, even before there could be any reference to the presence of buccal tentacles. The number of filaments is now doubled. In the vascular apparatus no essential alteration is yet perceptible, although lateral diverticula already appear on the radial canals, tending towards a union with the intermediate canals to form the annular canal.

The larvæ of about $2\frac{1}{2}$–3 millim. diameter show an essentially altered form, short pointed velar lobes making their appearance in the interradii, which already considerably exceed half the length of the radii. These stages already possess *a closed annular canal*, for the formation of which the diverticula of the radial vessels have united with the intermediate canals; and also four well-marked buccal arms beset with tentacles. They represent the *Floresca*-stage. Moreover the buccal arms, independently of the tentacular fringe on their elongated distal margin, already show a complication preparing the way for the future pairs of arms, in the shape of two lateral folds diverging in a fork distally. The number of filaments has advanced to 3–4 in each radius, and the occupation of the entoderm by vegetable cells is denser in comparison with the younger larvæ. In connexion with the appearance of the marginal corpuscles the cord-like constriction of the vascular canal and the dorsal dilatation above the otolith-sac seem worthy of notice.

With advancing growth the velar lobes, which are at first small and narrow, gradually increase in dimensions, while at the same time the periphery of the intermediate areas grows out at the expense of the lobes, which are transferred to the substance of the disk, and the velar lobules seem to advance more and more into the zone of the alternating ocular lobes. Under these changes the larva gradually loses the character of the Ephyra in favour of the young Acalephan form distinguished by a circlet of marginal lobes.

The sixteen areas of the vascular lamella become at the same time divided by vascular processes, which unite with each other into a great number of islets. First of all there is produced regularly between the radial canal and intermediate vessel a narrow pararadial vessel parallel to the latter, so that now thirty-two elongate ovate areas are present. These are then somewhat irregularly interrupted by transverse vascular diverticula, and even in larvæ 4 millim. in diameter the rapidly advancing development of irregular radial series of areas is commenced. The filaments are now already increased into small coil-like groups; and the buccal arms, by the enlargement of their processes, which are already contiguous, and by new formation of tentacles on their divergent terminal halves, have acquired a form in which the foundation of the pairs of arms unmistakably appears. Now also the complication of the vascular network makes rapid progress. Larvæ of 4½–5 millim. diameter, already furnished with four pairs of arms cleft at the extremity, represent the stage which I lately described and figured as the youngest *Cotylorhiza*-larva known to me*. The annular vessel, which was well marked at an earlier age, already appears indistinct and effaced to such a degree, that without a knowledge of the younger larvæ one might regard it as altogether suppressed, and come to the conclusion that the narrow-meshed vascular net of *Cotylorhiza* has a mode of formation quite different from that applying to *Rhizostoma* and the Aureliidæ. In larvæ of 7 millim. diameter, the areolation of the entodermal lamina already appears so narrow and close, and the frequently notched margin of the vascular network so far advanced peripherally, that the generic and family characters are recognizable. The further metamorphosis of the larva in connexion with the general form of the disk, the marginal lobes, and the structure of the brachial

* C. Claus, *l. c.* p. 52, figs. 106, 107. The average size is here, by an oversight, stated as too small; it amounts not to 3 millim. but to 5 millim.

apparatus has been fully described by me in the work above cited; and here I venture only to call attention particularly to the development of the nematophores, which also stand in an important relation to the establishment of points of amalgamation in the progress of the buccal arms, which are greatly enlarging and forming secondary infundibuliform folds.

In general therefore it appears (and the same may also recur in *Rhizostoma* and all Rhizostomeæ) that the early appearance of the buccal tentacles in the Cannostomous stage *is the primary process superinducing rhizostomism, then followed by the peculiar form of the four arms with their extended distal margin, and then paired foldings of the brachial processes.* From these stages onwards the development of rhizostomism depends essentially upon the continued folding of the surfaces of the arms, and their margins beset with tentacles, as I have already described in detail (C. Claus, *l. c.* p. 52 &c.).

As regards the yellowish-brown corpuscles which occur in great quantity in the entoderm of the larvæ of *Cotylorhiza*, they belong undoubtedly to the category of the plant-cells which vegetate symbiotically in so many of the lower organisms, first recognized as such by Cienkowski*, and subsequently distinguished by R. Brandt† as *zoochlorellæ* and *zooxanthellæ*. In *Cotylorhiza* they were detected some years ago by Hamann‡, but erroneously interpreted as unicellular glands with a difficultly recognizable aperture, until soon afterwards Patrick Geddes§ first demonstrated their true nature.

These chlorophyll corpuscles lie here and there singly, but generally in groups, in the cells of the entoderm, and project as globular or racemose balls into the jelly. Probably they have originated as products of continued division from a single cell; and, in point of fact, one meets with all transitions down to the bisection of the cell. I have never seen the zooxanthellæ completely separated from their union with the entoderm, although it is not improbable in itself that they might be transferred in o the jelly by entodermal cells which have

* Cienkowski, "Ueber Schwärmerbildung bei Radiolarien," in Archiv für mikr. Anat. 1871.

† K. Brandt, "Ueber das Zusammenleben von Algen und Thieren," in Biolog. Centralbl. 1881, no. 17; and also Geza Entz, *ibid.* 1882, no. 21.

‡ O. Hamann, "Die Mundarme der Rhizostomen," in Jenaische naturw. Zeitschr. Bd. xv. 1851. This author has lately recognized the error of his interpretation and retracted it.

§ Patrick Geddes, "On the Nature and Functions of the 'Yellow Cells' of Radiolarians and Cœlenterates," in Proc. Roy. Soc. Edinb. 1882.

wandered into the latter. Perhaps also by means of this supposition we may explain the free occurrence of the globular aggregations of yellowish-brown cells which C. Keller* has recently described in the jelly of his *Cassiopea polypoides*, and has interpreted, certainly erroneously, as a peculiar cell-form of the mesoderm.

The mode in which the chlorophyll-bearing algal cells, which also float very numerously free in the gastrovascular space, get into the entoderm, may be explained without difficulty by means of the faculty of amœboid movement now demonstrated in the case of the entodermal cells of the Medusæ. One might indeed imagine an active immigration on the part of the algal cells, which also have been known in the state of swarming; but the well-marked amœboid movements of the entoderm, which are so important for the inception of corpuscular elements, fully suffice to explain their introduction. Perhaps we may even succeed in obtaining this demonstration by direct observation; and for this purpose the Ephyra-stages may be particularly well fitted, as their gastral lining is not yet overcharged with zooxanthellæ. At a later age the filling up of the epithelium, especially in the close vascular ramifications, is so complete that one must take a good deal of trouble to find a free entodermal cell, at least in this section of the gastrovascular apparatus. The arms and funnel-frills also, as well as the central stomach and the filaments, contain the foreign guests so densely packed, that one is led to ask the question, whether there is any independent animal nourishment, and whether the superfluous assimilation-products of the zooxanthellæ, brought to the entoderm, do not suffice for the support of the Medusæ. With regard to this question, young *Cotylorhizæ*, which may be very well kept for months in the aquarium, would certainly be favourable objects of experiment, and would probably in essential points confirm the results obtained by K. Brandt† by experiments with *Anthea cereus*.

Hitherto I have not been so fortunate as to find the youngest Ephyræ of *Rhizostoma*, which have been sought after for years. However, I succeeded in obtaining a young form, 3½ millim. in diameter, which is notably inferior to the known and described stage, and by the small development of the velar lobes, which are already cleft, shows that the latter do not grow

* C. Keller, "Untersuchungen über neue Medusen aus dem rothen Meere," in Zeitschr. für wiss. Zool. Bd. xxxviii. 1883.

† K. Brandt, "Ueber die morphologische und physiologische Bedeutung des Chlorophylls bei Thieren," in Mittheil. aus der zool. Station zu Neapel, Bd. iv. Heft 2 (1883).

forth, as in *Cotylorhiza* and *Aurelia*, as unpaired tongue-shaped lobules, but in pairs as in *Discomedusa*. The annular vessel is already completely closed, but the buccal arms, abundantly beset with tentacles, are still simple and undivided. Probably the preceding Ephyræ, which have not yet been observed, agree with those of *Cotylorhiza*.

XXIII.—*The Lepidoptera collected during the recent Expedition of H.M.S. 'Challenger.'*—Part II. By ARTHUR G. BUTLER, F.L.S., F.Z.S., Assistant Keeper, Zoological Department, British Museum (Natural History).

THE first part of the Lepidoptera (which at the time I supposed to be the complete collection) obtained by the naturalists of H.M.S 'Challenger' appeared in the 'Annals' for June 1883, pp. 402–428; since the publication of that account, which embraced the species obtained in the Philippine, Aru, Admiralty, Fiji, and Friendly Islands, series have been received which were collected in the islands of St. Thomas, Bermuda, Rat Island, Ké Dulan, Ternate, and Amboina, amounting in all to one hundred and two species, which have yet to be recorded *.

The collections from St. Thomas and Bermuda being from the New World, are here treated separately from those of the other islands. They are as follows:—

RHOPALOCERA.

Nymphalidæ.

EUPLŒINÆ.

1. *Anosia leucogyne*, sp. n.

This is the West-Indian form of *A. plexippus* of North America, from which it chiefly differs in the external black border of the secondaries of the male being either unspotted or very imperfectly spotted with white; the female also is usually (though not invariably) paler, and has the outer border

* In an envelope were numerous specimens of *Pyrameis carye*, Hübn., two damaged specimens of *Leucania decolorata*, Blanch., and two unrecognizable Micro-Lepidoptera from Juan Fernandez, taken on the 14th and 15th November 1875; these I have not entered in this List.

of the secondaries less distinctly spotted with white than in the northern form. The expanse of wings varies from 76–106 millim., the females being not unfrequently dwarfed.

St. Thomas, March 1878.

The northern form, *A. plexippus*, is the type found in the Australian region.

Nymphalinæ.

2. *Dione vanillæ.*

Papilio vanillæ, Linnæus, Mus. Lud. Ulr. p. 306 (1764).

St. Thomas, March 1878.

The North-American species, which has hitherto stood as a synonym of this butterfly, being perfectly distinct both in size, form, pattern, and colour, must henceforth stand as *Dione passifloræ* (under which name it was figured by Abbot).

3. *Junonia cœnia.*

Junonia cœnia, Hübner, Samml. exot. Schmett. (1816–24).

St. Thomas, March 1878; Bermuda, in April.

Heliconinæ.

4. *Heliconius charithonia.*

Papilio charithonia, Linnæus, Syst. Nat. i. p. 757 (1767); Cramer, Pap. Exot. ii. pl. cxci. F (1779).

St. Thomas, March 1878.

The examples from St. Thomas are typical, and therefore distinct from those of Mexico and St. Domingo; the latter represent a larger longer-winged insect, with much narrower yellow bands; why it should not have been considered distinct by lepidopterists generally it would be hard to say.

Lycænidæ.

5. *Tmolus columella.*

Hesperia columella, Fabricius, Ent. Syst. iii. 1, p. 282. n. 83 (1793).

♂. St. Thomas, March 1878.

Papilionidæ.

Pierinæ.

6. *Appias Poeyi?*

Appias Poeyi, Butler, Proc. Zool. Soc. 1872, p. 49.

♂. St. Thomas, March 1878.

The specimen before me is slightly shorter in the wing than those which we have from St. Domingo and Honduras; but without seeing more specimens it would be rash to regard it as distinct.

7. *Ganoris cleomes.*

Pieris cleomes, Boisduval & Leconte, Lép. Am. Sept. p. 43, pl. xvi. (1833).

♂. St. Thomas, March 1878.

8. *Callidryas sennæ.*

Papilio sennæ, Linnæus, Syst. Nat. i. p. 764. n. 103 (1766).

♂ ♀. St. Thomas, March 1878.

9. *Terias euterpe.*

Colias euterpe, Ménétriés, Bull. Mosc. 1832, p. 299; Nouv. Mém. Mosc. iii. p. 121, pl. xi. fig. 4 (1834).

♂. St. Thomas, March 1878.

PAPILIONINÆ.

10. *Papilio polydamas.*

Papilio polydamas, Linnæus, Mus. Lud. Ulr. p. 192 (1764); Drury, Ill. Ex. Ent. i. pl. xvii. figs. 1, 2 (1773).

♀. St. Thomas, March 1878.

Hesperiidæ.

11. *Goniuris proteus.*

Papilio proteus, Linnæus, Mus. Lud. Ulr. p. 333 (1764); Clerck, Icones, pl. xlii. fig. 1 (1764).

St. Thomas, March 1878.

12. *Goniuris dorantes.*

Papilio dorantes, Stoll, Suppl. Cramer, pl. xxxix. fig. 9 (1790).

St. Thomas, March 1878.

13. *Proteides amyntas.*

Papilio amyntas, Fabricius, Syst. Ent. p. 533 (1775).

St. Thomas, March 1878.

14. *Pamphila pustula.*

Thymelicus pustula, Hübner, Zutr. exot. Schmett. figs. 625, 626 (1832).

♂ ♀. St. Thomas, March 1878.

15. *Pyrgus syrichtus.*

Papilio syrichtus, Fabricius, Syst. Ent. p. 534 (1775).

St. Thomas, March 1878.

Heterocera.

Sphingidæ.

16. *Chærocampa tersa.*

Sphinx tersa, Drury, Ill. Exot. Ent. i. p. 61, pl. xxviii. fig. 3.

Bermuda.

Arctiidæ.

17. *Composia sybaris.*

Phalæna (*Bombyx*) *sybaris*, Cramer, Pap. Exot. i. p. 112, pl. lxxi. fig. E (1779).

St. Thomas, March 1878.

Lithosiidæ.

18. *Deiopeia ornatrix.*

Noctua ornatrix, Linnæus, Syst. Nat. i. p. 839 (1766).

St. Thomas, March 1878.

Leucaniidæ.

19. *Leucania antica.*

Leucania antica, Walker, Cat. Lep. Het. ix. p. 100 (1856).

Bermuda, in April.

This species was evidently the commonest moth met with at Bermuda.

Xylophasiidæ.

20. *Laphygma macra.*

Laphygma macra, Guénée, Noct. i. p. 157. n. 251 (1852).

Bermuda, in April.

21. *Perigea subaurea.*

Perigea subaurea, Guénée, Noct. i. p. 227. n. 362 (1852).

Bermuda, in April.

I have little doubt that I have rightly identified this species, although Guénée's description of the secondaries is hardly satisfactory; they are not "clear ochreous," but pearl-whitish with golden reflections; here, as in the primaries, Guénée seems to have described the shot tints rather than the true colour of the wing.

Plusiidæ.

22. *Plusia ou.*

Plusia ou, Guénée, Noct. ii. p. 96 (1852).

Bermuda, April 1873.

Remigiidæ.

23. *Remigia marcida.*

Remigia marcida, Guénée, Noct. iii. p. 317 (1852).

Bermuda, April 1873.

Thermesiidæ.

24. *Thermesia monstratura.*

Thermesia monstratura, Walker, Cat. Lep. Het. xv. p. 1564 (1858).

Bermuda, April 1873.

Margarodidæ.

25. *Margaronia jairusalis.*

Margaronia jairusalis, Walker, Cat. Lep. Het. xviii. p. 524 (1859)

Bermuda, in April.

26. *Margaronia flegia.*

Phalæna-Pyralis flegia, Cramer, Pap. Exot. ii. p. 66, pl. cxl. fig. D (1779).

St. Thomas.

Botydidæ.

27. *Botys? onophasalis.*

Botys onophasalis, Walker, Cat. Lep. Het. xviii. p. 735. n. 326 (1859).
Botys thisoalis, Walker, *l. c.* p. 737. n. 329 (1859).

St. Thomas.

Without going into the whole history of the genus I will not follow the example of one of our rising lepidopterists and assert dogmatically that the above species either is or is not a true *Botys*; but one thing is certain, that the two names above associated were given to two specimens registered consecutively from the same collection. It is also certain that the species is nearly allied to Walker's "*Megaphysa?*" *serenalis*, which (in common with the other species referred by Walker to *Megaphysa*) has no affinity whatever to M. Guénée's genus.

Botys simmialis of Walker is also allied to *B. serenalis*.

Scopariidæ.

28. *Stenopteryx hybridalis.*

Pyralis hybridalis, Hübner, Pyral. p. 29, pl. xvii. fig. 114.

Bermuda, April 1873.

A few species were obtained at Teneriffe; but as they are well-known forms, it will be sufficient to enumerate them:—

Pararge meone, Esper; *Synchloe daplidice*, Linn.; *Ganoris rapæ*, Linn.; a small moth, the body of which is too much injured to allow of its identification (in size and form of wings it corresponds with *Sterrha sacraria*, but the neuration differs not a little); and an imperfect specimen of *Hypena obacerralis*, Walk.,—five species in all, three of which are butterflies and two moths, all taken on the 14th February, 1873.

The remaining collections are distributed as follows:—

	Rat Island.	Ké Dulan.	Ternate.	Amboina.
Radena meganira, *Godt.*	..	..	..	*
Limnas cratippus, *Felder*	..	..	*	
Salatura philene, *Cramer*	..	..	..	*
—— affinis, *Fabric.*	..	*		
Ravadeba cleona, *Cramer*	..	..	..	*
Hamadryas niveipicta, *Butler*	..	*		
Vadebra Zinckenii, *Felder*	..	..	..	*
—— Murrayi, *Butler*	..	..	..	*
Chirosa eurypon, *Hewits.*	..	*		
Hirdapa fraterna, *Felder*	..	*		
Salpinx pasithea, *Felder*	..	..	..	*

	Rat Island.	Ké Dulan.	Ternate.	Amboina.
Melanitis taitensis, *Felder*	..	..	..	*
—— solandra, *Fabric.*	..	..	*	
—— constantia, *Cramer*	..	..	..	*
Lethe arete, *Cramer*	..	..	..	*
Calysisme justina, *Cramer*	..	..	..	*
Mydosama remulia, *Cramer*	..	..	..	*
—— asophis, *Hewits.*	..	..	*	
—— sirius, *Fabric.*	..	..	..	*
Ypthima norma, *Westw.*	..	..	..	*
Doleschallia australis, *Felder*	..	*		
Messaras Crameri, *Felder*	..	..	..	*
Cethosia insulata, *Butler*	..	*		
—— cydippe, *Linnæus*	..	..	..	*
Hypolimnas nerina, *Fabric.*	..	..	*	
—— lasinassa, *Cramer*	..	..	..	*
Precis hedonia, *Linn.*	..	..	..	*
—— timorensis, *Wallace*	..	*		
Gerydus Boisduvalii, *Butler*	..	..	..	*
—— stygianus, *Butler*	..	..	*	
Tarucus plinius, *Fabric.*	..	..	..	*
Catochrysops trifracta, *Butler*	*			
Lampides ælianus, *Fabric.*	..	*		
—— ætherialis, *Butler*	..	*		
—— aratus, *Cramer*	..	..	*	*
Lycæna erinus?, *Fabric.*	..	..	*	
Delias plexaris, *Donovan*	..	..	..	*
Terias photophila, *Butler*	..	*		
—— biformis, *Butler*	..	..	..	*
—— puella, *Boisd.*	..	..	*	
—— lerna, *Felder*	..	..	..	*
Ornithoptera criton, *Felder*	..	..	*	
Papilio deiphontes, *Felder*	..	..	*	
—— nicanor, *Felder*	..	..	*	
—— severus, *Cramer*	..	..	..	*
—— Thomsonii, *Butler*	..	*		
—— ulysses, *Linn.*	..	..	..	*
—— polyphontes, *Boisd.*	..	..	*	
Hesperia celænus, *Cramer*	..	..	..	*
Pamphila Moseleyi, *Butler*	..	*		
—— phineus, *Cramer*	..	..	..	*
—— prusias, *Felder*	..	..	..	*
Padraona sunias?, *Felder*	..	*		
Tagiades japetus, *Cramer*	..	..	..	*
Protoparce cingulata, *Fabric.*	..	..	*	
Ophthalmis lincea, *Cramer*	..	*		
Cocytia Durvillei, *Boisd.*	..	*		
Euchromia ganymede, *Doubl.*	..	*		
Dyphlebia liboria, *Cramer*	..	..	..	*
Hypsa heliconia, *Linn.*	..	..	..	*

	Rat Island.	Ké Dulan.	Ternate.	Amboina.
Hypsa lanceolata, *Walker*	..	..	..	*
Cleis evander, *Cramer*	..	..	..	*
Artaxa simulans, *Butler*	..	..	..	*
Stilpnotia, sp.	..	..	..	*
Pegella ichorina, *Butler*	..	..	..	*
Bursada perdica, *Cramer*..........	..	..	..	*
Craspedosis ernestina, *Cramer*	..	..	..	*
Alcidis orontes, *Linn.*	..	..	..	*
Eumelea rosalia, *Cramer*..........	..	*		
—— ludovicata, *Guénée*	..	..	..	*
Xanthodes transversa, *Guénée*	..	*		
Spiramia funestis, *Butler*..........	..	..	..	*
Ophiusa simillima, *Guénée*	..	..	..	*
Glyphodes Ledereri, *Butler*	..	..	..	*

A series of Lepidoptera from Queensland was in such poor condition, and the species were so well known as common North-Australian forms, that I have not thought it worth while to record them; the most abundant species was *Ornithoptera richmondia*, Gray.

The following is a catalogue of the insular species:—

Nymphalidæ.

Euplœinæ.

1. *Radena meganira.*

Danais meganira, Godart, Enc. Méth. ix. p. 192 (1819).

♂ ♀. Amboina.

2. *Limnas cratippus.*

Danais cratippus, Felder, Sitzb. Acad. Wiss. Wien, math.-nat. Cl. xl. p. 449 (1860).

♂. Ternate.

3. *Salatura philene.*

Papilio philene, Cramer, Pap. Exot. iv. pl. ccclxxv. A, B (1782).

♂ ♀. Amboina.

4. *Salatura affinis.*

Papilio affinis, Fabricius, Syst. Ent. p. 511 (1775).

♂. Ké Dulan, 25th September, 1874.

5. *Ravadeba cleona.*

Papilio cleona, Cramer, Pap. Exot. iv. pl. ccclxxvii. F (1782).

♂. Amboina.

Up to the present time this species has been incorrectly identified in British collections, as evidenced by the locality given in Moore's recent Monograph—"Celebes." Cramer's species is of a pale (almost greenish) sulphur-yellow colour, not unlike the ground-tint of *R. lutescens*, but with the markings smaller and more restricted; on the other hand, the Celebes form (which may be called *R. luciplena*) is of a deep gamboge-yellow colour, especially in the male sex.

6. *Hamadryas niveipicta*, sp. n.

Closely allied to *H. nais* from Aru, but smaller; the spots on the primaries pure white (not greyish), sharply defined; a white longitudinal line from the base to the middle of the cell above, as well as below; the outer border of the secondaries narrower towards the anal angle than in *H. nais*. Expanse of wings 46 millim.

Ké Dulan, 25th September, 1874.

We also have a specimen in the Museum from N. Ceram.

7. *Vadebra Zinckenii.*

Euplœa Zinckenii, Felder, Reise der Nov. Lep. ii. p. 335.

♂ ♀. Amboina.

This is the Amboinese representative of *V. sepulchralis* of Java, specimens of which were evidently confounded with it by Felder.

8. *Vadebra Murrayi*, sp. n.

♂. Primaries above rich piceous brown (similar to *V. melina*), the external border and a diffused subapical band continuous with it slightly paler, and therefore redder in appearance: secondaries dark olivaceous brown, with white costal border; a diffused black nebula covering the lower half of the cell at the bases of the interno-median and median interspaces; external area, with the exception of the apical border, paler than the ground-colour: body dark piceous; head and collar black; the usual white dots on the collar. Wings below rufous-brown; primaries with the costal, subapical, and interno-median areas paler, the latter with two well-separated cinereous longitudinal streaks, the lower of which rests on the submedian vein; internal border white;

an oval bluish-white spot within the cell, a second lilacine white spot beyond it upon the second median interspace, and a large oval spot of the same colour below the latter on the first median interspace: secondaries with a bluish-white spot within the cell, and an arched series of six spots beyond it; three subapical white dots nearly parallel to the outer margin; the two usual white basal dots: body below much as in *V. melina* and allies. Expanse of wings 80 millim.

Amboina.

Decidedly smaller and of a different form from *V. melina*.

9. *Chirosa eurypon.*

Euplœa eurypon, Hewitson, Exot. Butt. ii. *Eupl.* pl. i. fig. 3 (1858).

♂ ♀. Ké Dulan, 25th September, 1874.

10. *Hirdapa fraterna.*

Euplœa fraterna, Felder, Reise der Nov. Lep. ii. p. 321.

♂. Ké Dulan, 25th September, 1874.

11. *Salpinx pasithea.*

Euplœa pasithea, Felder, Reise der Nov. Lep. ii. p. 318.

♂ ♀. Amboina.

Satyrinæ.

12. *Melanitis taitensis.*

Cyllo leda, var. *taitensis*, Felder, Verh. zool.-bot. Ges. Wien, xii. p. 493 (1862).

♂. Amboina.

13. *Melanitis solandra.*

Papilio solandra, Fabricius, Syst. Ent. p. 500 (1775).

♂. Ternate.

14. *Melanitis constantia.*

Papilio constantia, Cramer, Pap. Exot. ii. pl. cxxxiii. A, B (1779).

♀. Amboina.

15. *Lethe arete.*

Papilio arete, Cramer, Pap. Exot. iv. pl. cccxiii. E, F (1782).

♂ ♀. Amboina.

16. *Calysisme justina.*

Papilio justina, Cramer, Pap. Exot. iv. pl. cccxxvi. C (1782).

♂ ♀. Amboina.

17. *Mydosama remulia.*

Papilio remulia, Cramer, Pap. Exot. iii. pl. ccxxxvii. F, G (1782).

♂ ♀. Amboina.

18. *Mydosama asophis.*

Mycalesis asophis, Hewitson, Exot. Butt. iii. *Myc.* pl. iv. figs. 20, 21 (1862).

♀. Ternate.

19. *Mydosama sirius.*

Papilio sirius, Fabricius, Syst. Ent. p. 488 (1775).

♂. Amboina.

20. *Ypthima norma.*

Ypthima norma, Westwood, Gen. Diurn. Lep. pl. lxvii. fig. 1 (1851).

♂. Amboina.

Nymphalinæ.

21. *Doleschallia australis.*

Doleschallia australis, Felder, Reise der Nov. Lep. iii. p. 405, pl. li. figs. 1, 2 (1867).

Ké Dulan, 25th September, 1874.

22. *Messaras Crameri.*

Messaras Crameri, Felder, Sitz. Akad. Wiss. Wien, math -nat. Cl. xl. p. 449 (1860).

Amboina.

23. *Cethosia insulata.*

Cethosia insulata, Butler, Cist. Ent. i. p. 165 (1873).

Ké Dulan, 25th September, 1874.

24. *Cethosia cydippe.*

Papilio cydippe, Linnæus, Syst. Nat. i. p. 776 (1766).

♂. Amboina.

25. *Hypolimnas nerina.*

Papilio nerina, Fabricius, Syst. Ent. p. 509 (1775).

♂ ♀. Ternate.

26. *Hypolimnas lasinassa.*

Papilio lasinassa, Cramer, Pap. Exot. ii. pl. ccv. A, B (1779).

♂. Amboina.

27. *Precis hedonia.*

Papilio hedonia, Linnæus, Mus. Lud. Ulr. p. 279 (1764).

Amboina.

28. *Precis timorensis.*

Junonia timorensis, Wallace, Trans. Ent. Soc. 1869, p. 346.

Ké Dulan, 25th September, 1874.

Lycænidæ.

29. *Gerydus Boisduvalii*, sp. n.

Symæthus pandu, Boisduval (*nec* Horsfield), Voy. de l'Astrolabe, p. 73. n. 2 (1832).

♂ ♀. Amboina.

This species is considerably larger than that from Java, and, curiously enough, the colouring of the sexes is reversed, the male of the Amboinese species having the basal three fifths of the primaries white clouded with grey at the base, and the female with a narrow angulated white band, nearly as in *G. leos*.

30. *Gerydus stygianus*, sp. n.

Allied to *G. learchus*; above fuliginous brown with bronze reflections; a whitish fusiform spot at base of third median branch: wings below greyer than in Felder's figure of *G. learchus*, with a faint lilac tint, the markings rather narrower and the band across the disk of primaries uninterrupted. Expanse of wings 37 millim.

Ternate.

Unfortunately only one somewhat damaged example was obtained of this interesting species.

31. *Tarucus plinius.*

Hesperia plinius, Fabricius, Ent. Syst. iii. 1, p. 284 (1793).

♂. Amboina.

32. *Catochrysops trifracta*, sp. nov.

♂. Deep lilac, the thorax above blue-black; head white; palpi with the terminal joint and a dorsal line black; abdomen blackish grey: wings below much as in *C. cnejus*, but differing noticeably in the fact that the series of spots across the disk of the primaries, instead of forming one slightly irregular stripe, are broken into three parallel oblique bifid white-edged brown dashes, one below the other; the secondaries also have only one subanal black spot with pale yellow zone, and barely perceptibly touched with metallic scales. Expanse of wings 23–28 millim.

(Two damaged examples.)

Rat Island, Straits of Malacca, 1st September, 1873.

33. *Lampides ælianus.*

Hesperia ælianus, Fabricius, Ent. Syst. iii. 1, p. 280 (1793).

♂ ♀. Ké Dulan, 25th September, 1874.

34. *Lampides ætherialis*, sp. n.

♂. Pale silvery blue above; primaries with a narrow grey external border and blackish fringe: secondaries with a submarginal series of seven blackish spots, the fifth largest, the sixth and seventh confluent; a black marginal line; costal and abdominal borders pearl-white: body bluish white; head and collar brown. Wings below brownish grey, with white and black markings, arranged as in *L. aratus*, except that the orange zones of the ocelloid spots of secondaries are narrower. Expanse of wings 31 millim.

♀. Smaller, whiter above, the grey border of primaries broader. Expanse of wings 29 millim.

Ké Dulan, 25th September, 1874.

The male of this species is of a beautiful silvery-blue colour, most nearly approached in *Ialmenus evagoras* of Australia, but of a purer (less green) shade. The female is more like *L. aratus*.

35. *Lampides aratus.*

Papilio aratus, Cramer, Pap. Exot. iv. pl. ccclxv. A, B (1782).

♂ ♀. Amboina, Ternate.

36. *Lycæna erinus?*

Hesperia erinus, Fabricius, Syst. Ent. p. 525 (1775).

Ternate.

The examples are so much rubbed that it is impossible to be sure of this identification.

Papilionidæ.

Pierinæ.

37. *Delias plexaris.*

Papilio plexaris, Donovan, Ins. New Holl. pl. xviii. fig. 2 (1805).

♂ ♀. Amboina.

38. *Terias photophila*, sp. n.

♂. Gamboge-yellow, with black borders, as in *T. hecabe*, from which, however, it differs in being considerably smaller, in its pale colour, and narrower primaries; below lemon-yellow, the borders visible through the wings; the usual markings, with the exception of the black marginal dots, ill defined. Expanse of wings 32 millim.

Ké Dulan, 25th September, 1874.

Nearest in size, form, and pattern of primaries to *T. variata*, but deeper in colour, with well-defined border to the secondaries, and no subapical brown patch on the under surface of the primaries.

39. *Terias biformis*, sp. n.

Allied to *T. eumide* and *T. hecabe*, the male differing from the latter in its bright lemon-yellow (instead of deep gamboge) colour, the external border obliquely cut off at external angle and continued as a narrow squamose streak along the internal margin; the border of the secondaries narrower, more deeply sinuated, and terminating in a few brown scales at the first median branch, beyond which are only the usual black marginal dots; the female creamy white, with broad brown borders, formed as in the male of *T. sari*. Expanse of wings 43 millim.

♂ ♀. Amboina.

This is the first recorded instance of a species in this section of the genus having a white female. It is a most interesting form, being one of the links between the *T. rahel* and *T. hecabe* groups of species.

40. *Terias puella*.

Xanthidia puella, Boisduval, Voy. de l'Astrolabe, Lép. p. 60, pl. ii. fig. 8 (1832).

♂. Ternate.

41. *Terias lerna*.

Terias lerna, Felder, Sitzb. Ak. Wiss. Wien, math.-nat. Cl. xl. p. 448 (1860).

Amboina.

Papilioninæ.

42. *Ornithoptera criton*.

Ornithoptera criton, Felder, Wien. ent. Monatschr. iv. p. 225 (1860); Reise der Nov. Lep. i. p. 12, pl. iv. *a–c* (1865).

♂ ♀. Ternate.

Unfortunately, like all the specimens collected at Ternate, the pair obtained is much broken.

43. *Papilio deiphontes.*

Papilio deiphontes, Felder, Reise der Nov. Lep. i. p. 126 (1865).

♂. Ternate.

44. *Papilio nicanor.*

Papilio nicanor, Felder, Reise der Nov. Lep. i. p. 102, pl. x. *c*, *d* (1865).

Ternate.

45. *Papilio severus.*

Papilio severus, Cramer, Pap. Exot. iii. pl. cclxxvii. A, B (1782).

♂ ♀. Amboina.

46. *Papilio Thomsonii*, sp. n.

♂. Black-brown, primaries with paler scales sprinkled over the basal area, a costal and four discoidal divergent longitudinal lines of pale scales; costa, apex, and external border fuliginous brown; traces of an oblique, subapical, creamy whitish bar sometimes present; a broad irregular creamy-white belt or patch (somewhat as in *P. severus*, but wider and tapering to abdominal border, where it is squamose) across the extremity of the discoidal cell and the disk of secondaries; sinuations of the external border with narrow cream-white fringe: body as usual. Primaries below smoky brown, the cell and the disk from the upper radial, with the exception of the veins and a broad external border, blackish; sometimes three squamose oval creamy whitish spots placed obliquely beyond the cell; the divergent lines of scales as above: secondaries black-brown, smoky brown upon the basi-abdominal area, which is also sprinkled with white scales; no trace of the broad white belt of the upper surface; seven large black spots enclosing orange lunate spots parallel to outer margin; sinuations of outer margin white. Expanse of wings 113–120 millim.

♂. Ké Dulan, 25th September, 1874.

47. *Papilio ulysses.*

Papilio ulysses, Linnæus, Mus. Lud. Ulr. p. 201 (1764).

♀. Amboina.

48. *Papilio polyphontes.*

Papilio polyphontes, Boisduval, Sp. Gén. Lép. i. p. 268 (1836).

♀. Ternate.

The single damaged example before me differs slightly from the Celebesian type, the white areas on the primaries being interrupted by a rather broad and very oblique band of the ground-colour; this may, however, prove to be an individual variation.

Hesperiidæ.

49. *Hesperia celænus.*

Papilio celænus, Cramer, Pap. Exot. iv. pl. cccxcvi. A, B (1782).

♂. Amboina.

50. *Pamphila Moseleyi*, sp. n.

♂. Upper surface similar to *P. phineus*, but larger, blacker, the base not streaked with fulvous, the angular discal band of the primaries narrower and that of the secondaries nearly twice as broad; below these bands are decidedly yellow; the apical area of the primaries and the whole ground-colour of the secondaries are pale olivaceous instead of ochraceous or clay-coloured, and there is a large patch of black near the anal angle of the latter wings. Expanse of wings 47 millim.

Ké Dulan, 25th September, 1874.

51. *Pamphila phineus.*

Papilio phineus, Cramer, Pap. Exot. ii. pl. clxxvi. E (1779).

♂. Amboina.

Cramer's locality "Surinam" is here, as in other instances, erroneous; it is evident that some of the insects received by him from the two localities got confounded either through his own carelessness or that of those from whom he received them.

52. *Pamphila prusias.*

Pamphila prusias, Felder, Sitzb. Ak. Wiss. Wien, math.-nat. Cl. xliii. p. 44 (1861).

Amboina.

53. *Padraona sunias?*

Pamphila sunias, Felder, Sitzb. Ak. Wiss. Wien, math.-nat. Cl. xl. p. 462 (1860).

Ké Dulan, 25th September, 1874.

The single example before me is rather aberrant; it is, however, somewhat broken, and may be only individually separable from the Amboinese form.

54. *Tagiades japetus.*

Papilio japetus, Cramer, Pap. Exot. iv. pl. ccclxv. E (1782).

Amboina.

This species is also in the British Museum from Ké Island.

Sphingidæ.

55. *Protoparce cingulata.*

Sphinx cingulata, Fabricius, Syst. Ent. p. 545 (1775).

♂. Ternate.

The appearance of this New-World species at Ternate is very surprising; it is probably only an accidental immigrant. The specimen was much worn and shattered, and may have been long on the wing. Some of the Sphingidæ have been taken at an almost incredible distance from land, showing that their flight is not only extremely rapid, but capable of being sustained for a considerable time.

Agaristidæ.

56. *Ophthalmis lincea.*

Phalæna lincea, Cramer, Pap. Exot. iii. p. 61, pl. ccxxviii. B (1782).

Ké Dulan, 25th September, 1874.

Originally described from an Amboinese example supposed by Cramer to have come from Surinam; the species is found (and is probably common) at Ceram and New Ireland; an allied species, *O. bambucina,* takes its place in the Philippines.

Cocytiidæ.

57. *Cocytia Durvillei.*

Cocytia Durvillei, Boisduval, Mon. Zyg. p. 22, pl. i. fig. 1 (1829).

Ké Dulan, 25th September, 1874.

Not rare in New Guinea, though doubtless a rapid flier.

Zygænidæ.

58. *Euchromia ganymede.*

Glaucopis ganymede, Doubleday, Lort's Discov. Austral., Append. i. p. 519, pl. iii. fig. 3.

♂. Ké Dulan, 25th September, 1874.

Lithosiidæ.

59. *Dyphlebia liboria.*

Phalæna liboria, Cramer, Pap. Exot. iv. p. 106, pl. cccxlv. D (1782).

♀. Amboina.

60. *Hypsa heliconia.*

Phalæna (*Noctua*) *heliconia*, Linnæus, Syst. Nat. i. p. 839 (1766).

♂ ♀. Amboina.

61. *Hypsa lanceolata.*

Hypsa lanceolata, Walker, Cat. Lep. Het. vii. p. 1675 (1856).

♀. Amboina.

Originally described from a female obtained at Celebes. We have a male in the Museum probably from the same collection.

62. *Cleis evander.*

Papilio evander, Cramer, Pap. Exot. iv. pl. cccxxxi. F, G (1782).

♂ ♀. Amboina.

Liparidæ.

63. *Artaxa simulans*, sp. n.

A remarkable copy of *Ophthalmis lincea* from the same locality. Primaries black-brown, densely irrorated with black scales; a large ochreous spot at apex: secondaries with the basi-abdominal half black and the externo-apical half bright orange, the line of demarcation between the two areas being elbowed outwardly at the inferior angle of the cell: head, antennæ, collar, tegulæ, and prothorax ochreous; remainder of thorax and abdomen black; anal tuft pale testaceous. Wings below as above. Expanse of wings 47 millim.

Amboina.

This is one of those instances of mimetic assimilation so perfect as to catch the eye at the first glance. That the Agaristid is the species copied cannot be questioned, since it is not only a common form, but it belongs to a group which, like the allied Zygænidæ, is evidently distasteful to insect enemies.

64. *Stilpnotia*, sp.

A white species, too much injured to be described, but interesting as representing the genus in a locality where it would not have been supposed to occur.

♀. Amboina.

65. *Pegella ichorina*, sp. n.

♀. Allied to *P. curvifera*. Primaries above white, crossed by three nearly equidistant golden-brown stripes—the first interrupted, angulated, just before the basal fourth of the wing, the second rather broad, oblique, crossing the middle of the wing, and confluent with an angular discocellular fasciole of the same colour, the third narrow, oblique, crossing the disk halfway between the central stripe and the outer margin; two or three basal spots, the veins, a spot in the cell, and a marginal series of spots golden brown: secondaries rose-pink, becoming gradually white towards outer margin, where there is a series of little brown dashes: body above sordid whitish; antennæ black. Wings below white, showing traces of the markings of the upper surface; costal borders and veins sordid; marginal spots or dashes as above; interno-median area of primaries slightly tinted with pink; secondaries with the basal two thirds tinted with pink; abdominal area washed with rose-pink: body sordid whitish; anterior legs blackish. Expanse of wings 100 millim.

Amboina.

Euschemidæ.

66. *Bursada perdica.*

Phalæna perdica, Cramer, Pap. Exot. ii. p. 126, pl. clxxviii. E (1779).
Var. *Bursada truncata*, Walker, Cat. Lep. Het. Suppl. p. 191 (1864).

♂ ♀. Amboina.

Of this species an instructive series was obtained, completely linking the two forms associated above.

67. *Craspedosis ernestina.*

Phalæna Geometra ernestina, Cramer, Pap. Exot. iv. p. 155, pl. ccclxix. F (1782).
Celerena sobria, Walker, Cat. Lep. Het. Suppl. p. 164 (1864).

♂ ♀. Amboina.

In his 'Catalogue' Walker states that *C. sobria* is the type of his genus *Celerena*; the latter genus, however, had been already described by him in the 'Transactions of the Entomological Society' for 1862, pp. 71, 72, with *C. divisa* as type. The two species are not congeneric.

Uraniidæ.

68. *Alcidis orontes.*

Papilio orontes, Linnæus, Amœn. Acad. vi. p. 402.

♀. Amboina.

Palyadæ.

69. *Eumelea rosalia.*

Phalæna Geometra rosalia, Cramer, Pap. Exot. iv. p. 152, pl. ccclxviii. F (1782).

Ké Dulan, 25th September, 1874.

70. *Eumelea ludovicata.*

Eumelea ludovicata, Guénée, Phal. i. p. 393.

Amboina.

Acontiidæ.

71. *Xanthodes transversa.*

Xanthodes transversa, Guénée, Noct. ii. p. 211 (1852).
Xanthodes intercepta, Walker (nec Guénée), Cat. Lep. Het. xii. p. 778 (1857).

Ké Dulan, 25th September, 1874.

Walker transposed *X. transversa* and *intercepta* in his 'Catalogue.'

Hypopyridæ.

72. *Spiramia funestis,* sp. n.

♂. Nearest to *S. spiralis*; velvety fuliginous brown, paler beyond the middle and at the base of the primaries, the pale area being bounded by an elbowed black stripe; two ill-defined blackish diffused discal stripes, the inner one separating the dark and pale areas, sinuous on the primaries and regularly undulated but straight and central on the secondaries, the outer one bounding the external area, terminating before the apex of the primaries in an oblique angle and barely visible upon the secondaries; the usual spiral ocelloid marking with the spot unusually small and less black than usual; external area slightly greyish, fringe whitish: primaries with a submarginal series of black dots: thorax as usual, brown varied with black; abdomen velvety black, with the two terminal segments vermilion. Wings below smoky brown, with pale fringe; the primaries crossed beyond the middle and the secondaries in the middle by two parallel dusky stripes, slightly inangled towards the costal margin of primaries and arched on the secondaries: body below vermilion; tibiæ and tarsi brown; anus pale ochreous. Expanse of wings 71 millim.

♂. Amboina.

Ophiusidæ.

73. *Ophiusa simillima.*

Ophiusa simillima, Guénée, Noct. iii. p. 266 (1852).

Amboina.

Margarodidæ.

74. *Glyphodes? Ledereri*, sp. n.

Glyphodes actorionalis, Lederer (nec Walker), Wien. ent. Monatschr. vii. pl. xiv. fig. 4 (1863).

Amboina.

Walker's species comes nearer to Lederer's *G. Zelleri*. I am not satisfied that *G. Ledereri* is a true *Glyphodes*.

XXIV.—*Report on the Polyzoa of the Queen Charlotte Islands.* By the Rev. THOMAS HINCKS, B.A., F.R.S.

[Concluded from page 58.]

[Plate IX.]

Suborder CYCLOSTOMATA.

Family **Crisiidæ.**

CRISIA (part.), Lamouroux.

Crisia cornuta, Linnæus.

Houston-Stewart Channel; Virago Sound; common.
[Norway, Britain, Brittany, Mediterranean.]

Crisia eburnea.

Virago Sound.

[North and Arctic Seas, St. Lawrence, Labrador, St. George's Banks, California, Fiji Islands, New Zealand and Australia, Madeira, Mediterranean, Britain.]

Crisia denticulata, Lamarck.

Houston-Stewart Channel.

[Kara Sea, Norway, Spitzbergen, Grand Manan, Britain, Adriatic, Madeira, South Africa.]

Family **Tubuliporidæ.**

STOMATOPORA, Bronn.

Stomatopora major, Johnston.

On shell, rare.
[Bergen, Britain, Brittany.]

Stomatopora diastoporides, Norman.

On shell.
[Entrance of Baffin's Bay, Gulf of St. Lawrence, Britain.]

Stomatopora incrassata, Smitt.

A specimen occurs exhibiting the anastomosing habit which is characteristic of British examples of this species.
Cumshewa; Houston-Stewart Channel.
[Spitzbergen, Nova Zembla, Kara Sea, Britain.]

TUBULIPORA, Lamarck.

Tubulipora lobulata, Hassall.

Houston-Stewart Channel, on shell.
[Scandinavian coasts, Britain.]

Tubulipora perfragilis, n. sp.

Zoarium adnate, white, and composed of very delicate material, consisting of a short stem, widening upwards, which divides dichotomously into two principal branches, these again subdividing dichotomously, the lower segments curving downwards so as almost to surround the point of origin and the stem, and giving to the whole colony a flabellate form; branches slender at the base, expanding upwards, thickly covered with the cells, occasionally a second expansion originating from the summit of the first, to which it is connected by a narrow base. *Zoœcia* crowded on the branches, radiately disposed, very slender, with a speckled surface, a large portion of the length free and subhorizontal, sometimes connate and in companies of 2–4, sometimes single and detached; orifice orbicular, unarmed. *Gonocyst* an irregular inflation of the surface of the branch, minutely punctate.

On shell.

This form has some points of resemblance to *Tubulipora capitata*, mihi ('Annals' for August 1881, "Contributions towards a General History of the Marine Polyzoa"), an Australian species; but there are differences in the habit of growth and in some of the details of structure which probably entitle it to a distinct name. The present species is exceedingly delicate and of most graceful form. The branches seem to be slightly attached and are commonly free towards the extremities; the tubes are remarkably slender, and the free portions are horizontally inclined rather than erect. *T. perfragilis* bears much resemblance to D'Orbigny's figure of his *Idmonea cenomana* (Pal. Franç., Terr. Crétacés, vol. v. Atlas, pl. 633. fig. 2).

Tubulipora Dawsoni, n. sp. (Pl. IX. fig. 5.)

Zoarium forming a spreading, irregularly shaped, intricate, coral-like mass, composed of many branches, much divided and subdivided dichotomously, which radiate from the point of origin and anastomose freely; branches massive, of considerable width, somewhat compressed, flattened in front, expanding upwards, bifid or trifid at the extremities, which are cellular, recumbent or suberect, never adnate, but attached by numerous calcareous offsets from the dorsal surface to the shell or stone on which the colony grows. *Zoœcia* arranged (in part) in transverse rows (two to five in each), which slant slightly downwards, connate, with a large suborbicular orifice, increasing in height from the inner side outwards, so as to give a serrated appearance to the edge of the branch; the rows sometimes extending to the centre of the branch, but not separated by any distinct mesial line, sometimes (and more commonly) ranging along the sides, the centre being occupied by many detached cells irregularly distributed, with a suborbicular orifice, which is usually scarcely raised above the surface; walls thickly and minutely punctate; the dorsal surface rounded, lineated longitudinally, punctate, often with transverse furrows.

Common amongst the dredgings; on shells and stones.

In this fine species the disposition of the cells connately in transverse rows is very much confined to the sides of the branch, and a striking characteristic is the crowd of scattered cells which very commonly fills the centre. The latter are generally very slightly raised above the surface of the zoarium. The rows vary in length and occasionally extend to the centre of the branch; but usually the condition is as I have described it. The zoœcia composing them increase in height from within outwards, and the tallest form a conspicuous line along the margin of the branch. The branches are for the most part broad and compressed, and inosculation takes place freely. A peculiarity which at once arrests attention is the large development of dorsal appendages for the purpose of attachment: these are short, cylindrical, calcareous processes, which are given off in great number from the under surface of the branches, and become firmly soldered to the body on which the polyzoon grows (Pl. IX. fig. 5 *a*).

I have great pleasure in naming this form, which is a very characteristic member of the Polyzoan fauna of the Queen Charlotte Islands, after Dr. G. M. Dawson.

Tubulipora fasciculifera, n. sp. (Pl. IX. fig. 6.)

Zoarium flat, thin, closely adnate, flabellate. *Zoœcia* free and erect above, depressed below, the free extremities disposed in short, disconnected, more or less divergent series, which range in radiate fashion (but somewhat irregularly) towards the margin, the series sometimes composed of a single line of connate tubes, sometimes of two lines placed side by side, sometimes of clusters (or fascicles) of tubes; orifice orbicular, unarmed; surface thickly speckled. *Gonocyst* an inflation of the zoarium, usually placed near the margin, involving a number of the zoœcial tubes; surface covered with minute disks closely packed together.

On shell.

The fasciculate arrangement of the zoœcia is the most distinctive character of the present species, but many single lines of cells mingle with the composite series. It grows in flabellate patches, which sometimes give off long linear or subclavate lobes. The free portion of the cell is much elevated and more than suberect.

So far as the character and arrangement of the zoœcial series are concerned, the Cretaceous *Multifascigera Campicheana*, D'Orbigny, curiously resembles the present form (see Paléont. Franç. vol. v., Atlas, pl. 762. fig. 8).

DIASTOPORA (part.), Lamouroux.

Diastopora patina, Lamarck.

Cumshewa, on *Tubulipora* and *Myriozoum*.

[North and Arctic Seas, South Labrador, Britain, France (S.W.), Adriatic.]

Diastopora sarniensis, Norman.

Off Cumshewa, 20 fms.

[English coasts (south-west and south-east), Mediterranean (probably).]

Diastopora suborbicularis (?), Hincks.

[=*D. simplex*, Busk.]

On shell.

[Greenland, Finmark, Britain, Naples.]

A single specimen occurs, imperfectly developed, which seems to have the characters of this species. A larger portion of the cell is free than is usual in *D. suborbicularis*; but there is always much diversity in this respect, due to difference of habitat. The margin of the zoarium is slightly lobate, but this may be owing to the immature condition of the specimen.

Family **Lichenoporidæ.**

LICHENOPORA, Defrance.

Lichenopora hispida, Fleming.

On shell.

[Norway, Finmark, Greenland, South Labrador, Britain, France (S.W.), Naples.]

Lichenopora verrucaria, Fabricius.

Virago Sound, on *Sertularella*.

[Norway, Arctic Seas, Bay of Fundy, St. George's Banks, Britain (North and West).]

Suborder CTENOSTOMATA.

Family **Alcyonidiidæ.**

ALCYONIDIUM, Lamouroux.

Alcyonidium gelatinosum, Linnæus.

Virago Sound.

[North and Arctic Seas, North America, Britain, Natal.]

Family **Vesiculariidæ.**

BOWERBANKIA, Farre.

A member of this genus occurs on Sertularians from Virago Sound, which is probably referable to *B. imbricata*, Adams, form *densa*, Farre.

[White Sea, Caspian Sea, Britain.]

Family **Buskiidæ.**

Buskia, Alder.

Buskia nitens, Alder.

Virago Sound, on a Sertularian; also creeping over *Cellaria*.
[Davis Straits, White Sea, Barents Sea, Britain.]

Family **Cylindrœciidæ.**

Cylindrœcium, Hincks.

Cylindrœcium giganteum, Busk.

In the specimens which I refer to this species, the cell is of more slender habit than in British examples and the ectocyst less opaque; but these differences are of slight moment, and I have little doubt that the Pacific form is specifically identical with our own.
[Britain.]

[Group **ENTOPROCTA.**]

Order PEDICELLINEA.

Family **Pedicellinidæ.**

Pedicellina, Sars.

Pedicellina gracilis, Sars.

Virago Sound.
[Norway, Spitzbergen, White Sea, Britain.]

APPENDIX.

Family **Cellulariidæ.**

Menipea ternata, Ellis & Solander.

The form occurs in which the two lower cells in the triplet are much elongated and attenuated, and the habit in consequence is much more slender and graceful than in the normal condition. Smitt has recorded this variety from the north.

Menipea compacta, n. sp., form *triplex*.
(Pl. IX. fig. 8.)

[Described in 'Annals' for December 1882, p. 461.]

Only a small and imperfectly developed example of this species occurs amongst Dr. Dawson's dredgings; but very fine specimens from California (where it seems to be extremely abundant) and Vancouver Island enable me to correct my description of it in one or two particulars.

I find that on the same colony internodes composed of three cells are mingled with others bearing five or six, so that it is incorrect to designate the triple condition as a distinct form. We have a similar variation in *Menipea ternata*. The operculum is not "acicular," as described, in its fully developed state, though always very moderate in size. It is usually, in its perfect condition, clavate, expanding slightly above.

M. compacta grows in luxuriant bushy tufts, which bristle with spines.

Family **Cellariidæ.**

Cellaria mandibulata, n. sp. (Pl. IX. fig. 7.)

[Described in 'Annals' for December 1882, p. 463.]

The figures represent the avicularium, which exhibits probably the least specialized form of the appendage in the Cellarian series, and a shoot of the natural size, in which there is a curious departure from the usual dichotomous ramification. The branches are given off from the stem at intervals on each side, instead of forming a fork at the joints. This peculiarity, however, does not appear to be characteristic of the species.

Family **Membraniporidæ.**

Membranipora velata, Hincks.

This Californian species occurs on shells dredged off Cumshewa; but the specimens from the Queen Charlotte Islands are destitute of the large avicularia. (See 'Annals' for August 1881, p. 130.)

Membranipora acifera, MacGillivray, form *multispinata*.

['Annals' for December 1882, p. 465, pl. xix. fig. 4.]

In a previous portion of this Report I have referred a *Membranipora* from the Queen Charlotte Islands to the *M. acifera* of MacGillivray*, of which it seemed to me to be a variety. But in a paper read before the Royal Society of Victoria, October 12, 1882, MacGillivray states that further examination has led him to identify this species with his *Membranipora serrata*, which is certainly quite distinct from the North-Pacific form. I shall therefore characterize the latter as

* Described and figured in a paper read before the Royal Society of Victoria, December 9, 1881.

Membranipora pallida, n. sp.

Zoœcia elongate-oval, front wall wholly membranous, quincuncially disposed, margin thin, smooth, usually slightly elevated at the top; an erect spine on each side above and from six to eight slender pointed spines down each side, which incline inward; generally at the bottom of the cell, on a small quadrate area, an *avicularium* with an expanded base (occupying the area) and a very long, slender, tapering beak, which stretches upward along the margin; mandible triangular below, above setiform. *Oœcium* (?).

Zoarium whitish, texture delicate.

Virago Sound; spreading luxuriantly over shell.

Membranipora exilis, n. sp.

[Described in 'Annals' for December 1882, p. 466.]

On further examination of this species I find that it agrees with *M. radicifera*, Hincks, in being attached (in some cases at least) by radical tubes given off from the dorsal surface. It is not closely adnate to the surface on which it grows, as most of the *Membraniporæ* are, but is furnished with special organs of attachment. The first specimen which came under my notice (and on which my description was based) is growing on *Cellaria borealis*, the stem of which *it loosely invests*; in this case I have not been able to detect any of the dorsal appendages. But on a colony which spreads over a *Tubulipora* they are present in great numbers, and there can be no doubt that it is anchored by the radical tubes and not adhesive. In both cases the dorsal surface of the cells is convex and rounded, and clearly unfitted for direct attachment. Probably the presence or otherwise of the appendages is dependent on the nature of the habitat.

I have already ('Annals' for July 1881, p. 5, under *Membranipora radicifera*) drawn attention to certain links connecting the Membraniporidan series with such forms as *Bugula* and *Diachoris*. We have another such link in the present species. A *Membranipora* which, from the nature of its habitat, had ceased to be adherent and had developed radical fibres as a means of attachment, would have made a very decided advance towards the Bugulan type.

Family **Porinidæ.**

Lagenipora spinulosa, n. sp.

[Described in 'Annals' for January 1884, p. 57.]

When I first described this species I had only met with small incrusting colonies, and was under the impression that they represented the mature and perfect form. I now find, however, that this is by no means the case. When fully grown the zoarium of *Lagenipora spinulosa* is erect and ramose (Pl. IX. fig. 4), consisting of a cylindrical stem, which divides and subdivides dichotomously, the branches terminating above in short bifid segments. The *zoœcia* are arranged longitudinally in six lines along the stem and branches, those in neighbouring lines alternating; the oral (or neck-like) portion free and projecting, the lower immersed. The surface of the cell is covered with very large foramina, which are closed in by membrane. *Primary orifice* elliptical, slightly narrowed below. The surface of the *oœcium* is smooth, and entire behind; a raised line arches across it towards the front, and the portion in advance of this line is covered with minute disks closely packed together.

In its perfect condition this species bears a close resemblance, so far as habit and general appearance are concerned, to an *Entalophora*.

The wall of the cell is built up of tubes placed longitudinally and closely appressed to one another; this curious structure may be best observed in the erect neck-like portion of the zoœcium. The superficial foramina are probably the openings of the tubes.

The lateral avicularia are supported on a tubular structure, which may be traced stretching down the inner wall of the oral cylinder (neck) and tapering off finely below. *Lagenipora spinulosa* would seem to be abundant where it occurs; it must be accounted one of the most interesting forms which Dr. Dawson's dredgings have yielded.

Family **Myriozoidæ** (part.).

Schizoporella cruenta, Norman.

This species must be added to the list of North-Pacific forms. The single specimen which occurs is in fine condition, and has the oral sinus much more strongly marked than the British examples which I have examined. The deep-red colour of the zoarium when fresh has given place to a uniform black.

[Nova Zembla, Greenland, Britain, from Shetland to the Channel Islands.]

Schizoporella biaperta, Michelin.

A specimen has occurred in which the oral avicularia assume both the round and spatulate form, as is commonly the case in the allied *Schizoporella armata*, mihi.

Schizoporella Dawsoni.

[Described in 'Annals' for June 1883, p. 449.]

The species described under the above name I have now no doubt is identical with *Escharina torquata* of D'Orbigny ('Voyage dans l'Amérique méridionale,' tome v. 4e partie, p. 11, =*Flustra torquata*, Lamouroux). *Schizoporella torquata* must therefore take the place of *S. Dawsoni* in the Report. I have, however, much pleasure in dedicating a fine species of *Tubulipora* (which I trust will prove to be undescribed) to the able investigator to whom we are indebted for our knowledge of the marine fauna of the Queen Charlotte Islands.

Schizoporella torquata (D'Orbigny), Lamx.
(Pl. IX. fig. 2.)

Virago Sound, on shell.
[Bay of Rio, on dead shells.]

Schizoporella linearis, Hassall, form *inarmata.*

The only specimens amongst the dredgings which are referable to this species are totally destitute of avicularia. In other respects they agree with the typical form, and must be regarded as an unarmed variety.

[Scandinavia, South Labrador, Mediterranean, Britain, France (S.W.).]

Family **Escharidæ** (part.), Smitt.

Lepralia cleidostoma, Smitt, var.

A variety of this species occurs which is destitute of avicularia. There is frequently a small knob on each side of the orifice, and always a stout mucro immediately below it. The oœcia do not exhibit the striæ which Smitt describes, but are smooth and polished. The only specimen, however, which I have examined is strongly calcified and has a highly varnished surface, and in this condition the striæ may be obliterated. An Australian variety has already been described with circular instead of pointed avicularia ('Annals' for August 1881, p. 122).

? *Porella argentea*, n. sp. (Pl. IX. fig. 1.)

Zoœcia ovate, quincuncial, rather depressed (sutures shallow), surrounded by raised lines, surface thickly covered with punctures; orifice expanded above and well arched, contracted below; peristome slightly raised, especially above, a very prominent hinge-denticle on each side a little above the lower margin; immediately below it an umbonate swelling, bearing on its inner aspect an *avicularium*, with rounded mandible, directed upwards. *Oœcium* rounded, not prominent, surface somewhat roughened, usually a circular pore on the front. *Zoarium* white and silvery.

Houston-Stewart Channel, on shell.

Mucronella spinosissima, Hincks.

On further examination I find that in the younger cells there are two or three lines of pores forming a belt round the margin; and it seems probable that the curious tubular system which I have described ('Annals' for January 1884, p. 53) owes its origin to these. At least I can only explain it by supposing that, as calcification proceeds, it is arrested by the pores, and only extends round them and not over them; so that they continue open, and form at last tubular shafts piercing the stony crust which has been piled up about them.

Retepora Wallichiana, Hincks.

This species has been obtained in Vancouver Island.

General Remarks.

The number of species recorded in the present Report from the Queen Charlotte Islands is 96, of which 36 appear to have been hitherto undescribed. Of the 60 species known to science more than a third (24 at least) seem to be distinctively Arctic forms, and of these 17 occur in the British seas *. Migration has taken place on the side of Davis Straits and Behring Straits: on the one the circumpolar species have distributed themselves along the North-American coasts and more or less widely along those of the British Islands; on the other they have colonized the nearer portions at least of the North Pacific. In the comparatively warm waters which

* The seven Arctic species which occur in the Queen Charlotte Islands but not in Britain are *Cellaria borealis*, *Flustra membranaceo-truncata*, *Membranipora Sophiæ*, *Smittia plicata*, *Retepora Wallichiana*, *Cellepora incrassata*, and *Myriozoum coarctatum*. The whole number of species common to the Islands and Britain is forty-three.

bathe the shores of the Queen Charlotte Islands they evidently find a congenial home and are finely developed. There is nothing to show that they are unfavourably affected by the change of climate. Of these northern forms only one seems to reach the Mediterranean; a few are widely distributed in the British seas, while the rest are pretty much confined to Shetland and the north-east and north-west coasts. In Prof. Verrill's 'Check-List of the Marine Invertebrata of the Atlantic coast, from Cape Cod to the Gulf of St. Lawrence' (1879) thirty-one species are included which occur in the Queen Charlotte Islands, and of these nineteen are Arctic; so that the results of the northern migration have been much the same on both sides of the continent.

The remaining species obtained by Dr. Dawson constitute a somewhat miscellaneous company. They include a small group of cosmopolitan forms which occur in almost all latitudes, and are expected, as a matter of course, to be present wherever Polyzoa are found. Such are *Microporella ciliata* (perhaps the most widely distributed species in the class), *Schizoporella hyalina* (which almost equals it in this respect), *Smittia trispinosa*, and perhaps *Hippothoa distans*. A few species occur which have been found as far up the Pacific coast of America as California and Vancouver Island, but which are not known as Arctic forms. These are no doubt southern species which have travelled so far northwards. Indeed the Queen Charlotte Islands are, in a remarkable degree, the meeting-ground of northern and southern forms. *Membranipora Rosselii*, *M. tenuirostris*, *Cribrilina radiata*, *Schizoporella Cecilii*, *S. sanguinea*, *S. torquata*, and *Diastopora suborbicularis* are essentially southern.

Seventeen species are common to the Islands and Australia, and of these thirteen are also European: nine of them occur in the Arctic seas. Two have only been found, so far, in Australia and the Queen Charlotte Islands (*Porella marsupium* and *Mucronella spinosissima*). *Lepralia cleidostoma* has occurred in these two localities and off the coast of Florida.

It may be noted here that of the whole number of Queen Charlotte Islands species only nine are not also European.

Some of the ascertained facts respecting the distribution of the Polyzoa are sufficiently perplexing, and we must wait for a larger accumulation of data before we may hope to explain them satisfactorily. The way in which certain species are strewn, as it were, at haphazard over the surface of the globe is a difficulty of which the solution is not apparent. We must, I think (as I have suggested before), make large allowance for the agency of man, and of currents, floating weed and timber, &c., in the diffusion of the species, apart from the general laws which preside over the distribution of life.

Further light will no doubt be thrown on the relations of the Polyzoan fauna of the Islands when we know more of the history of the group of new forms recorded in this Report. We may venture, I think, to say, that they are not to any large extent Arctic. Are they southern coast-line emigrants, or do they occupy their original home?

EXPLANATION OF PLATE IX.

Fig. 1. ? *Porella argentea*, n. sp.
Fig. 2. *Schizoporella torquata* (D'Orbigny), Lamx.
Fig. 3. *Cellepora*? n. sp. (*brunnea*); a cluster of zoœcia, showing one of the marginal decumbent cells.
Fig. 4. *Lagenipora spinulosa*, n. sp.; erect form, nat. size.
Fig. 5. *Tubulipora Dawsoni*, n. sp., nat. size. 5 *a*. Portions of the stem showing the offsets from the dorsal surface, by which the zoarium is attached. 5 *b*. Portion of a branch, showing the disposition of the zoœcia. 5 *c*. The extremity of a branch, showing the cellular capitulum and several of the scattered central zoœcia.
Fig. 6. *Tubulipora fasciculifera*, n. sp.; portion of the zoarium, showing the arrangement of the zoœcia. 6 *a*. A colony, nat. size.
Fig. 7. *Cellaria mandibulata*, n. sp.; avicularian cell. 7 *a*. Nat. size, showing a peculiarity in the ramification.
Fig. 8. *Menipea compacta*, n. sp.; front view of an internode. 8 *a*. Dorsal surface.

XXV.—*On* Schizoporella Ridleyi, *MacG.*, *and* Schizoporella simplex, *D'Orbigny and Johnston*. By J. J. Quelch, B.Sc. Lond., Zoological Department, British Museum.

The *Schizoporella Ridleyi*, MacGillivray, was orignally described as *S. marsupium* by Mr. Ridley, who identified it with *Lepralia marsupium*, MacG., having been misled by the short and incomplete description of this species, which was, moreover, as stated since by Mr. MacGillivray, drawn up from a bad specimen. And certainly, if excuse were needed for such an identification, I may state that the agreement between the type specimen of the 'Alert' collection described by Mr. Ridley, and the description and figures of *L. marsupium* given by Mr. MacGillivray in the Prodr. Zool. Vict. decade iv., seems to me much closer than is the agreement between the figures given since by Mr. MacGillivray (Roy. Soc. Vict. 1882) for *Porella* (*Lepralia*) *marsupium* and his previous description and figures of the same species.

The 'Alert' species, being found by Mr. MacGillivray to be distinct from his *Porella marsupium*, was named by him after Mr. Ridley; and as some misconception of the real characters of the species exists, I have deemed it advisable, after examining the type specimen, to give a more detailed description than has been given of a few of its leading features, in order to point out its specific distinctness from *Schizoporella* (*Escharina*) *simplex*, D'Orbigny, to which species Mr. Hincks has recently assigned it (Ann. & Mag. Nat. Hist. January 1884, p. 51).

The most striking feature of *Schizoporella Ridleyi* is the infraoral, bluntly-pointed projection on which the avicularian pore is situated. This is not merely a swelling of the common wall of the zoœcium, for where the projection has been broken away a delicate membranous wall still remains beneath it in continuity with the zoœcial wall. It seems rather to be the basal portion of the avicularian cell itself, which entirely occupies the large circumscribed area below the mouth of the cell, as originally pointed out by Mr. Ridley.

A clearer idea of this projection will be formed by viewing it from the side, so that it may be seen in profile, as it would be if a median longitudinal section of it were made. It will then be seen to arise, at its inferior part, somewhat above the middle of the zoœcium, as a slightly convex line forming an angle of at least 45° with the surface-wall of the zoœcium, continuing outwards and forwards until it is joined by a line drawn from the sinus in the lower lip of the mouth at right angles to the zoœcial wall. The length of this perpendicular line gives the height of the projection above the zoœcium; and this corresponds very nearly with the length of the cell-mouth, except in the youngest zoœcia at the edges of the colony, where the projection is smaller, but still quite distinct and prominent. This raised portion, seen from the front, is nearly semicircular in outline, the curved portion terminating at the lateral angles of the mouth, while the straight, flat, superior portion forms a platform, so to speak, immediately below the mouth. At the outermost pointed limit of this platform is the avicularian opening, which can only be distinctly seen by looking down from the top of the zoœcium, as it were.

The lower lip of the aperture of the zoœcium in this species is straight, with a shallow median rectangular sinus; there is no sinus in the edge of the infraoral projection, that shown apparently in such a position in figures of the species being really in the lower lip of the aperture of the cell, supposed to be seen above the projection; the surface is glistening and more or less hyaline, almost smooth or very finely and sparsely punctated; the zooecia are convex, nearly as broad as long, separated by rather deep depressions, the sutures being thin lines often slightly raised. In the type specimen I can find no distinct areolations, such as those mentioned by Mr. MacGillivray, around the margins of the old cells, but there are often faintly marked radiating lines; two short lateral spines are almost constantly present on the aperture, three or four longer ones being on the young zooecia.

On comparing this more complete description of the species with the description and figures of *Escharina simplex*, D'Orb., I think it must be considered that the two species are quite distinct. In this *Schizoporella* (*Escharina*) *simplex*, D'Orb., attention must be called to the rounded lateral angles of the mouth producing an oval shape transversely, to the rather deep rounded sinus of the lower lip, to the complete absence of spines, to the numerous and distinct punctures on the surface of the zooecium, and more especially to the nature of the "tubercule" below the mouth on which the pore is situated—this "tubercule" being present as a rounded protuberance of the wall, seen, in the lateral view that D'Orbigny gives in fig. 8, as being scarcely raised above the general surface of the zooecial wall, whereas in *Schizoporella Ridleyi*, MacG., this projection forms a comparatively immense rostrum.

Even making allowance for the probable incompleteness of D'Orbigny's description and figure, and for a possibly great variability in the species, it does not seem to me that differences such as those mentioned taken together can be safely regarded as being within the limits of specific variation; and hence it seems that the two species must be considered distinct.

In any case, however, *Schizoporella* (*Escharina*) *simplex*, D'Orb., seems to be sufficiently diagnosed to be recognized; and as, I believe, it claims priority over *Schizoporella simplex*, Johnston, this latter name must give way. D'Orbigny's species bears the date 1839 against it, and is printed in Part 4, vol. v. of the 'Voy. dans Amér. Mérid.,' which bears the date of publication 1839–46. Dr. Johnston's species was published in the second edition of the 'Zoophytes' in 1847.

For this form described by Dr. Johnston, which is thus destitute of a name, I propose that of the distinguished author, so that the species may be known as *Schizoporella* (*Lepralia*) *Johnstoni*.

XXVI.—*On new* Stylasteridæ.

To the Editors of the Annals and Magazine of Natural History.

Gentlemen,—In the current February number of the Ann. & Mag. Nat. Hist. I notice that Mr. Quelch (Brit. Mus. Zoological Department), in describing some new forms of the above group, has criticized a paper of mine published in vol. ix. (1882), in which I described two new forms of *Distichopora*; and I crave to be allowed space for a few lines in reply, the more so as his remarks are slightly inexact or misleading.

I did not profess to give a complete list of the Distichopores either of the Pacific or any other region, but only so far as suited the object I had in view. Of the two species referred to as absent, *D. livida*, Tenison-Woods, was published in New South Wales (1879–80), and *D. fragilis*, D., I do not know. Does Mr. Quelch mean *D. gracilis*, Dana? I do not find either species mentioned in the list of "all the species known," as given by Mr. Moseley in the 'Challenger' Reports, vol. ii. (1880 and 1881), so that if I have sinned at all I did so in good company. *I did not* say *D. nitida*, Verrill, was of a whitish tint, but that *most* of the West-Indian &c. species were; and this is correct (see "Pourtalès," &c.). I find, however, on looking at the original references, I have inadvertently transposed the species; but this does not affect the question in any way.

With regard to *D. Brasseyi* and *D. Allnutti*, opinions will always vary as to the limits and definition of a species; yet it wants but a fair examination of the beautiful and accurately coloured lithographic plates of the two forms (reduced to scale) and the figure of the life-sized fronds, with a careful reference to the description of each, to see that two species, let them be called as they may, are sufficiently indicated. Prof. Verrill gives no figures, and in a critical examination of a group of organisms more or less closely allied a simple diagnosis does not always suffice. If it did, having Verrill's and Tenison-Wood's descriptions (and a figure of the latter) of their respective species to direct him, why has Mr. Quelch appended a query (?) to the names of the examples assigned by him to these species in the cases under his charge in the British Museum? Having compared the above as now exhibited with the species described by myself, I see no reason to reverse my opinion as to their distinctness. Had I seen Mr. Tenison-Wood's paper and figure earlier *I might* have hesitated before describing *D. Allnutti* as a new species; but as it is, in the absence of *authentic* examples, and there being some features in which the descriptions of the two species do not quite harmonize, I feel justified in retaining my opinion as to their difference. *D. nitida* of Verrill, as judged by the Museum examples, it certainly is not. The latter is probably the same as the unnamed fragments I mentioned in my paper as being in the Museum collection. I have not as yet seen a second example of *D. Brasseyi*; but in Lady Brassey's collection are several specimens of *D. Allnutti*, some fronds being very large, much more so than is given by Mr. Tenison-Woods.

I am, Gentlemen,
Yours obediently,
BRYCE WRIGHT.

204 Regent Street, W.
Feb. 18, 1884.

BIBLIOGRAPHICAL NOTICE.

Catalogue of the Fossil Sponges in the Geological Department of the British Museum (Natural History); with Descriptions of new and little-known Species. By GEORGE JENNINGS HINDE, Ph.D., F.G.S. 4to. London: printed by order of the Trustees. 1883.

THERE is certainly no group of organisms that has presented so many difficulties to naturalists as the Sponges. The very kingdom of nature to which they belonged was long a matter of dispute; indeed, not much more than thirty years ago so good a naturalist as Carl Vogt, after briefly discussing their peculiarities, decided that they were at least quite as much plants as animals, and showed that he thought they were less animals than plants by leaving them out of his 'Zoologische Briefe.' Even since their recognition as members of the animal series they have been subjected to vicissitudes such as have fallen to the lot of no other group: after passing for a time as undoubted Protozoa, they were raised by Leuckart and Häckel on embryological grounds to the rank of Metazoa, and finally ranked by Saville Kent as Flagellate Infusoria, while Balfour was inclined to regard them as forming a group in some respects intermediate between Protozoa and Metazoa.

With organisms as to the absolute nature of which such divergent opinions prevailed, with such complete uncertainty with regard even to what constitutes the individual "persona," it is no great matter of wonder that the views of zoologists upon their classification and as to the characters which ought to be employed to distinguish them were irreconcilably diverse, and that for many years spongologists were occupied chiefly with investigations which could only be regarded as tentative. Gradually, however, some order began to be evolved out of the chaos. Bowerbank, Gray, and Carter in this country, Oscar Schmidt and others in Germany, proposed systems of classification, in which, although they could not be maintained in their entirety, certain well-marked groups were indicated; and the recognition of these, coupled with the great mass of information accumulated by these authors, paved the way towards an intelligible systematic treatment of the class of Sponges.

If there was all this difficulty in dealing with the recent forms, it is not surprising that the fossil sponges were treated after a very conventional fashion. The characters derived from the constitution of the skeleton, upon which it was shown more and more that we must chiefly rely in determining the nature and affinities of these organisms, were often lost or rendered exceedingly difficult of recognition by the process of fossilization, and palæontologists until quite recently founded their genera and species almost wholly upon the general form and other surface-characters of the fossils. By this means in some instances allied forms were roughly brought together in a manner which might suffice for stratigraphical purposes; but in all other respects our knowledge of the fossil sponges was most unsatisfactory. A few species and genera had been described by various authors with reference to their skeletal and other structural characters, but no respectable attempt to construct a classification of fossil sponges was made until the publication of Prof. Zittel's admirable "Studien über fossile Spongien" in the Memoirs of the Bavarian Academy for 1877 and 1878. That author having taken up the study of the fossil sponges as far as possible on the same principles as are applied to the recent forms, with a view to the preparation of his 'Handbuch der Paläontologie,' a portion of which has made its appearance, was led to the establishment of a remarkably broad and simple classification, which at once took its place as the certain foundation for all future work in this department of palæontology.

Some three years ago Dr. G. J. Hinde was applied to by the Keeper of the Geological Department of the British Museum to undertake the preparation of a Catalogue of the Fossil Sponges in the national collection. Already well known as a careful worker in several branches of what Ehrenberg denominated "Micro-geology," Dr. Hinde had been attracted to Munich by the publication of Prof. Zittel's memoirs above referred to, and had remained at Munich for a considerable time, availing himself of the instructions of Prof. Zittel and of the magnificent series of preparations of sponges, recent and fossil, which that gentleman had collected during the progress of his own researches. Dr. Hinde's qualifications for the task offered to him, both natural and acquired, were therefore of the highest order; and we are not surprised to learn that under these circumstances the original rather scanty design was in course of time expanded into the much more satisfactory form of which the present volume is the result. The first idea was that of arranging the fossil sponges in the Museum systematically, "and preparing a simple catalogue of their specific names and references;" but examination of the collection soon showed that "numerous specimens, more particularly those from British strata, were either quite new to science or had been described and figured in such an imperfect manner that their real characters were unknown." Accordingly "with the consent of the Trustees, it was decided to enlarge the plan and embrace in the Catalogue condensed descriptions of all the species from British strata and of the new species from foreign localities, with figures of all the new forms as well as of those which had been either inadequately figured previously, or of which it was desirable to illustrate the minute structure." Looking at the result, we think that all parties are to be congratulated upon the course that was pursued in this case,—the Trustees for the enlightened liberality which led them to accede to the increased expenditure required, the Keeper of the Geological Department for the valuable work done in the collection under his charge, and the credit attaching to his department through the production of a most valuable contribution to palæontological literature, and the author upon the satisfactory conclusion of his three years' labour and the magnificent style in which his work has been brought out. Nor must we omit to congratulate the working palæontologist upon the acquisition of such a valuable help to the study of perhaps the most difficult group of fossil organisms.

In his treatment of the systematic part of his work, the catalogue proper, the author, as might be expected, follows implicitly the classification of Prof. Zittel, which, as he says, is "the only one, in fact, which is at all applicable." The sponges are referred to the same orders and the same families, and for the most part to the same genera, as by Zittel; but, especially among the British forms, the author has met with many which he was unable to place in any extant genera, and for these new generic groups are proposed. That he has not exercised this power of genus-making recklessly, however, is shown by the fact that out of 139 genera cited only 18 are characterized as new, a degree of reticence which is truly praiseworthy in an author who has had through his hands a mass of specimens referred to over 400 species of organisms so obscure and difficult of investigation that few will have the courage or even the opportunity of criticizing his work. To save space the genera of former writers are not characterized, except in those few cases in which Dr. Hinde has departed more or less from Prof. Zittel's views, so that, so far as the characters of the genera are concerned, the student will have to supplement this catalogue with Zittel's 'Studien' (a translation of which appeared in this journal at the time of their appearance *), or with the abridgment of that work in the 'Neues Jahrbuch,' reprinted and issued separately in 1879 under the title of 'Beiträge zur Systematik der fossilen Spongien.' It is, we think, to be regretted that the short characters of orders, suborders, families, and genera contained in the last-mentioned work were not translated or abridged and given under the respective

* Ser. 4, vol. xx., and ser. 5, vols. ii. and iii. (1877–79).

groups; twenty more pages would have sufficed for this, and the usefulness of the book to students would have been immensely increased.

Out of the 248 pages of which this volume is composed, the actual catalogue of species, including the descriptions, occupies 193; the remainder is devoted to a brief introductory chapter, a tabular and a stratigraphical list of species, a bibliography, and a copious index. The introduction treats very briefly of a few general matters connected with fossil sponges and their mode of occurrence, and deals especially with those curious phenomena of fossilization involving the replacement of silica by carbonate of lime and *vice versâ*, about which there has been considerable discussion of late years. This introductory portion concludes with a few remarks upon the geological distribution of sponges, and on the classification of the fossil forms, with a classified list of the orders, families, and genera referred to in the body of the work. The tabular list of species, in which those occurring in Britain are specially indicated by an appended asterisk, shows in vertical columns the distribution of the species in the broader divisions of geological time; while the stratigraphical list displays the same series of facts arranged from a geological point of view. This latter list brings into prominence a remarkable point, namely, that the earliest sponges of all, the Cambrian *Protospongia fenestrata* and the three species recorded from Dr. Hicks's Ordovian strata, all belong to the Hexactinellidæ, which have commonly been regarded as the most complex of sponges. Further it would appear that while the Cretaceous deposits swarm with the remains of these organisms, they are represented far more scantily in the Tertiary deposits. The British Museum collection possesses only some forms of *Cliona* from the Tertiaries.

We trust that it will be very clearly seen from this short notice that Dr. Hinde, in this Catalogue, has furnished his *confrères* with a most valuable treatise; in fact, with this work and those of Prof. Zittel already referred to, the Sponges, from a literary point of view, may be regarded as perhaps the most favoured group of fossil organisms. But we have yet to say a few words about the plates with which the volume is illustrated, as these contribute in no small degree to its usefulness and importance. There are no fewer than thirty-eight of these plates, and they are for the most part beautifully executed, showing in a most characteristic fashion the external appearance of the fossils, with many of which one is tolerably familiar, and also the spicular and other structural characters known chiefly to students of the group. These illustrations, which by their beauty and number admirably illustrate the text and help to render this the finest palæontological treatise that has issued from the English press for many years, reflect the highest credit upon the artists concerned in their production—a credit, however, which they must be content to share with the author, as in such a case as this we may be pretty sure that without the most careful superintendence on his part, such excellent results as we here meet with could not have been attained.

MISCELLANEOUS.

Preliminary Report on the Expedition of the 'Talisman' in the Atlantic Ocean. By M. A. Milne-Edwards.

At the public meeting of the five Academies on the 25th October, 1882, I had the honour of giving an account of the explorations of the 'Travailleur,' and I announced that this year a new scientific campaign would take place in the Atlantic. In fact, the Minister of Marine, in reply to a desire expressed by his colleague the Minister of Public Instruction and by the Academy, had given the necessary orders that a despatch-ship, the 'Talisman,' should be fitted out for that purpose.

The 'Talisman' is an excellent screw-steamer, provided with powerful sails, sufficient without the help of its machinery to give it a rapid motion. During several months, in the dockyards of the arsenal at Rochefort, it was placed in the hands of the Marine engineers, who undertook to adapt it to the service which it was to fulfil. The old hempen ropes intended to raise the dredges were replaced by a steel cable of extreme firmness and flexibility, able to support, without breaking, a weight of nearly 4500 kilogrammes, and presented to the Admiralty by the Minister of Public Instruction*. Two steam-engines secured its action: one of them set in motion the enormous reel on which it was coiled; the other, which was more powerful, drew up the dredging-apparatus. Some large nets or trawls of 2 or 3 metres across the mouth replaced with advantage the heavy dredge which we formerly employed. The soundings were made by means of an apparatus perfected by M. Thibaudier, marine engineer, and arranged in such a manner that the movements of the vessel should have no influence on the tension of the steel rope; an automatic brake arrested the unwinding directly the sounding-apparatus touched the bottom. In order to measure the temperatures of the deep strata of the water I had caused to be constructed an apparatus enabling a thermometer with a broken column of mercury to turn over at a given moment. The same movement caused the breakage of the capillary extremity of glass tubes in which a vacuum had been produced, and into which the sea-water then rushed, furnishing samples of perfect purity, which could be indefinitely preserved after hermetically sealing the tubes.

Our *confrère*, Colonel Perrier, was kind enough to lend me a Gramme machine, which furnished electricity to some Edison lamps, so placed as to illumine our apparatus, or, at need, to descend into the sea to a depth not exceeding 35 metres. At my request the command of the vessel was confided to Captain Parfait, who, the preceding year, occupied the same post on board the 'Travailleur'†.

* The weight of a metre was 344 grammes, and the price about 0 fr. 62.

† The staff was composed of M. Antoine and M. Jacquet, lieutenants, of MM. Gibory and Bourget, ensigns, of M. Vincent, doctor, and M. Huas, assistant doctor, and of M. Plas, purser.

I may here be permitted to express to the officers of the 'Talisman' all the gratitude with which their courtesy has inspired us. They interested themselves in our work with an ardour which never flagged, and if we have completely succeeded in our mission it is to them that we owe our success.

On the 30th of May the scientific commission met at Rochefort *, and on June 1st the 'Talisman' quitted port.

The expedition of 1883 may be subdivided into several distinct sections:—we had in the first place as our object to study the coast of Africa as far as the Senegal; then to explore the neighbourhood of the Cape-Verd Islands, the Canaries, and the Azores, volcanic lands which could not fail to furnish us with some interesting facts; lastly, we hoped to pay some attention to the Sargasso Sea, from the point of view of its fauna and the nature of its bed.

The depths which extend to the west of Morocco and the Sahara are of very great regularity; one no longer finds there that disturbed relief which, on the coasts of Spain, had rendered our operations so difficult. On the contrary, the slope is gradual, and by travelling further from or nearer to the land one can find, almost certainly, the depth that one expected. On these bottoms we used the dredge about 120 times, and at the end of some days we knew the bathymetric distribution of the animals of this region well enough to be able to indicate from the contents of our nets what had been the depth explored.

At 500 or 600 metres live numerous fishes, such as *Macrurus*, *Malacocephalus*, *Hoplostethus*, and *Pleuronectes*, as well as some shrimps of the genus *Pandalus* and of a new species with a rostrum pointed like a sword, species of *Peneus* and *Pasiphaë*, some small crabs (Oxyrhynchi, Portunidæ, and Ebalidæ), some rose-coloured Holothurians, some rare specimens of *Calveria*, that soft sea-urchin discovered in our seas by the naturalists of the 'Porcupine,' and known previously in the fossil state, and many sponges of great size, such as *Askonema* and *Farrea*.

At a greater depth, about 1000 or 1500 metres, fishes abound †. Often they constituted the greater part of our booty. Their colours are, in general, dull, their flesh is gelatinous, their skin is indued with a thick coat of mucus; many bear phosphorescent plates, intended to light them in the darkness where they live.

The *Pandali* have given place to the new genus *Heterocarpus*, Peneidæ in which the last two pairs of legs are long and articulated like antennæ; and to enormous shrimps of a blood-red colour and

* The commission was composed of M. A. Milne-Edwards, of the Institute, president, of MM. de Folin, Vaillant, Perrier, Marion, Filhol, and Fischer, to whom had been added, as assistants, MM. Brongniart and Poirault. Detained at the last moment by his university duties, M. Marion was unable to embark.

† There are still *Macruri*, to which are to be added the following genera:—*Bathynectes*, *Coryphænoides*, *Malacocephalus*, *Bathygadus*, *Argyropelecus*, *Chauliodus*, *Bathypterois*, *Stomias*, *Malacosteus*, *Alepocephalus*.

with excessively long antennæ, which were not known, and which ought to be placed in the genus *Aristæus*. *Nephropses* appear at this level; these are blind Crustaceans, of a coral-colour; their geographical distribution seems to be very extended, for they have been found on the other side of the Atlantic, in the Caribbean Sea, and a very nearly allied species has been taken at a great depth in the neighbourhood of the Andaman Islands. The blind *Polycheles*, which replace in existing nature the Jurassic *Eryons*, hide themselves in the mud, and only allow their long hooked claws, destined to seize their prey in passing, to protrude.

Some other crabs occur; some Maiidæ (*Scyramathia*, *Lispognathus*); Homolides of a new species; and some species of *Lithodes*, a genus which was thought to be peculiar to the northern and southern seas. Numerous species of the group of the Galatheidæ were observed, of which several have the eyes transformed into spines. The sponges are extremely common; the greater number have a siliceous skeleton. We have taken a profusion of *Rossellæ* and *Holteniæ* of several species, of which the fibres, like snow-white crystal, are buried in the mud, while the sponge alone emerges; and some *Aphrocallistæ*, of which the solid framework assumes the most elegant forms. The *Calveriæ* become more numerous; Holothurians (*Lætmogone* and others) crawl on the ground in the midst of Asterians, Ophiurans, and *Brisingæ*. Our nets often came up charged with such riches that the day did not suffice to classify them.

Passing Cape Ghir and Cape Nun, at about 120 miles from the coast, the 'Talisman,' during several days, explored a very regular bank, of which the depth is about 2000–2300 metres. It was upon this same bank that, on August 2, 1882, the 'Travailleur' captured the singular fish described by M. Vaillant under the name of *Eurypharynx pelecanoides*, and of which two examples have been taken this year. Our dredgings were once more of great value. Superb sponges, allied to those which have been described under the name of *Euplectella suberea*, occurred, mixed with great violet Holothurians of the genus *Benthodytes* and with other species of the same kind, remarkable for their dorsal appendages. A *Calveria* distinct from those of lesser depths, *Brisingæ*, corals of rare beauty (*Flabellum*, *Stephanotrochus*), a *Democrinus*, and a *Bathycrinus* not yet described, very numerous Crustaceans, nearly all new to us and belonging to the group of Galatheidæ (*Galathodes*, *Galeantha*, *Elasmonotus*), completed the invertebrate fauna. The fishes were very varied, and their study will furnish new facts of the greatest interest. Amongst the most remarkable I will mention *Melanocetus Johnsoni*, some *Bathytroclites*, a *Stomias* with phosphorescent plates, and several *Malacostei*.

Between the Senegal and the Cape-Verd Islands our nets attained a depth of 3200 and 3655 metres, and brought up the greater part of the preceding species as well as many others (crustaceans, mollusks, zoophytes, sponges) which had not been met with elsewhere.

These last dredgings terminated the first part of our expedition, and on the 20th July, after fifty-one days' sailing, we cast anchor in the Bay of Praia, at Santiago, in the Cape-Verd Islands.

These volcanic islands detained us some days, and while zoological, botanical, and geological excursions were made on land, the 'Talisman' investigated the irregular littoral regions in search of marine animals, and, in particular, the red coral which has been for some years the object of an active commerce on these shores. I shall not dwell upon these littoral researches any more than upon the exploration of the islet of Branco, where we studied, in their home, the great lizards (*Macroscincus Coctei*), which seem to be confined to this isolated rock. All these details find their place in the report which I have addressed to the Ministry, and of which the publication will take place shortly.

In the depths of these seas off Cape Verd, life has an astonishing vigour. Our nets came up filled to the brim; at one cast we have taken more than 1000 fishes, belonging for the most part to the genus *Melanocephalus*, more than 1000 *Pandali*, 500 shrimps of a new species with enormously long legs (*Nematocarcinus*), as well as many other species.

On the 30th July, the 'Talisman' started to the north-west and sailed towards the Sargasso Sea. I will not enlarge upon this part of our journey; it will be sufficient for me to say that in no part have we met with those floating meadows of which the older navigators speak. The Sargassos appeared in isolated bundles floating, in definitely oriented lines, in the direction of the winds or of the currents, and sheltering a whole pelagic population of which the colours harmonized admirably with those of the seaweeds which serve them as a refuge; the naturalists on board made a careful study of them.

The soundings of the 'Talisman' in this part of the Atlantic show in a general way that, starting from the Cape-Verd Islands, the bottom deepens regularly to about the 25th parallel, where it reaches 6267 metres, then it gradually rises again towards the Azores, and under the 35th parallel it is no longer more than 3000 metres. These results are far from agreeing with the curves indicated on the most recent bathymetric charts. The bed of the Sargasso Sea seems to be formed of a thick layer of very fine mud of a pumiceous nature, containing fragments of pumice-stone and of volcanic rocks.

It seems that there may be here, at more than a league below the surface of the water, an immense volcanic chain parallel to the coast of Africa, and of which the Cape-Verd Islands, the Canaries, Madeira, and the Azores would be the only emergent points.

The submarine fauna is poor; it is composed of a few fishes, of some Crustaceans, such as *Paguri*, lodged in colonies of *Epizoanthi*, shrimps of the genus *Nematocarcinus*, and species of *Pasiphaë*, and of a few Mollusca (*Fusus*, *Pleurotoma*, and *Leda*), which scarcely sufficed to compensate us for the time which dredgings so deep as these occupied.

It was not until about the northern limit of the Sargasso Sea, where the bottom is raised to 3000, 2500, and 1500 metres, that our captures again became abundant; it was here that we took the giant of the family of the Schizopodes, a *Gnathophausia* of a blood-red colour, measuring almost 0·25 metre in length. A short stay of the 'Talisman' at Fayal and afterwards at St. Michael, in the Azores, enabled us to compare the still active volcanic phenomena with those which we had just studied at the summit of the Peak of Teneriffe.

The analogy of the rocks, of the gaseous products, and of the deposits of sulphur is striking, and, from what takes place at the surface of the ground, one can form an idea of the submarine convulsions which have covered the bed of the Sargasso Sea with pumice and igneous rocks.

Our voyage from the Azores to France was made under excellent conditions, and every day a dredging was made at depths of from 4000 to 5000 metres. These difficult operations, very skilfully conducted by Captain Parfait, brought to us harvests of extreme importance.

Under this crushing pressure, in a dark medium and without traces of vegetation, the animals are numerous and of a very perfect organization.

Great fishes of the genus *Macrurus*, as well as *Scopeli* and *Melanoceti*, seem not to be rare there. Some Hermit Crabs and Galatheidæ of a new form, a gigantic Nymphonid of the genus *Colossendeis*, some unknown *Ethenæ*, some Amphipodes, and some Cirripedes represent the Crustaceans. But this abyssal fauna owes its physiognomy especially to the number, variety, and size of the Holothurians which dwell there.

The sea-bottom is carpeted in all that region with a thick white mud, almost entirely formed of *Globigerinæ*, and covering pumice and fragments of rocks of different natures, of which some bear the impressions of fossils, and, among others, of Trilobites; but what surprised us most was to find, at a distance of more than 700 miles from the coast of Europe, pebbles polished and striated by ice. The distinctness of these striæ does not allow us to suppose that they were transported by currents. The presence of these pebbles is probably due to the action of floating masses of ice which, at the quaternary epoch, advanced further towards the south than at the present day, and which, melting in that part of the Atlantic comprised between the Azores and France, let fall on the bottom stones which they had previously carried along torn from the bed of the glaciers.

On the 30th August we dragged our nets for the last time on the rapid declivity which unites the abysses of the ocean with the depths of the Bay of Biscay, and our captures added to the fauna of the French seas a great number of new or interesting species. It was time to return to Rochefort: our casks and jars were full, our alcohol was exhausted. This expedition has furnished us with incomparable materials for study; it remains now to set to work upon them. The Minister of Public Instruction recognizes the importance of this, and he has been kind enough to furnish me with the means of commencing the publication of the results. Finally I intend to place before the public in a special exhibition, which will take place at the Museum about the end of the month, the collections gathered during the expeditions of the 'Travailleur' and the 'Talisman.'—*Comptes Rendus*, December 17, 1883, p. 389.

New Aphidological Discoveries. By M. Lichtenstein.

Thanks to the assistance of several foreign entomologists, among whom M. Howath of Budapest and M. Kessler of Cassel occupy the first place, I have been able to ascertain absolutely the fact of the migration of the Aphides of the elm to the roots of grasses, and their return to the trunks of the trees in autumn.

Tetraneura ulmi of authors, the commonest of the Aphides of the elm, upon the leaves of which it forms little smooth, green galls the size of a large pea or a hazel-nut, lives, during its subterranean *budding* phase, on the roots of maize in Austria and Hungary, and here on the roots of the dog's-tooth grass (*Cynodon dactylon*). Passerini and many others had made of this subterranean Aphis a distinct species under the name of *Pemphigus Boyeri*, Pass., = *radicum*, Boyer, = *Zeæ maidis*, Löw & Duf., &c. &c. As there are very probably many species which live upon the roots of plants in summer (in my own opinion nearly all the gallicolous species have their corresponding subterranean form), the characters of these insects vary much according to authors; but the *Tetraneura ulmi* seems to me to be very well characterized and easily recognized by the fifth joint of the antennæ being as long as the third.

I have conveyed winged insects taken from the roots of the dog's-tooth grass upon a strip of brown paper, fixed round a young smooth-barked elm, with the view of giving them an artificial shelter between the paper and the bark. They did not attempt to fly away; on the contrary, they set to work at once to deposit sexual pupæ, which soon opened and furnished males and females, destitute of rostra, as in most Pemphiginæ. What is more, the next day all the winged Aphides of the roots in the neighbourhood seemed to have appointed to meet on my strip of paper, which swarmed with insects, drawn together probably by the inexplicable instinct of the lowest forms of animals.

At the same time I was able to ascertain the arrival upon the same tree of a second species, *Tetraneura rubra*, Licht., which forms small *red*, *curled*, and *villous* galls upon the leaves. After pulling up some hundreds of different plants I also found the subterranean habitat of this species; it is the *Panicum sanguinale*. In this species the apterous form is reddish, while it is quite white in *Tetraneura ulmi*. The winged forms have the fifth joint of the antennæ shorter than the third.

I still (10th December) find wingless Aphides alive upon the roots, which would prove that, as in the *Phylloxera*, side by side with the winged pupiferous form which gives origin to the sexual reproducers, there is, parallel with this reproduction, an uninterrupted sequence of subterranean agamic reproduction, so that, should any circumstance happen to destroy the *winter-egg*, there is always a subterranean provision of reproduction ready to replace the sexual generation which has not prospered.

Moreover, in the case before us, the winter-egg, that is to say the fecundated egg of the *Tetraneura*, besides being well sunk into the fissures of the bark, is further protected by the dried skin of the mother, for she does not expel it, but keeps it encysted within her, as do the Aphides of the galls of the *Lentiscus* observed by Prof. Derbès. Thus protected the egg braves the attacks of mites, Hemerobii, Thrips, and other small enemies.

In indicating the two species of grasses upon which I have found the subterranean forms of *Tetraneura*, I do not wish to imply that they do not attack others; on the contrary, I know very well that Passerini, for example, cites eleven species of grasses upon which he has found his *Pemphigus Boyeri*, which now becomes synonymous with *Tetraneura ulmi*; and as the latter is everywhere very common, it is very probable that in countries where maize or the dog's-tooth grass are wanting, it contrives to find other grasses to its taste. I believe this species is polyphagous.

But if it is polyphagous in its subterranean phase, it appears to be very faithful to the elm and even to *Ulmus campestris* in forming its gall. In fact I have, side by side with *Ulmus campestris*, two or three plants of *Ulmus effusa*, a tree very nearly allied to the former species, which the botanists can hardly distinguish except by the form of the flowers. Now at this present moment the elms have neither leaves nor flowers, and I put the same strip of paper upon *Ulmus effusa* as upon *Ulmus campestris*; nevertheless the insect makes no mistake, and I never find a *Tetraneura* upon the *Ulmus effusa*. On the other hand there is upon the latter tree a peculiar gall of a species of Aphis very nearly allied to *Tetraneura*, namely *Schizoneura compressa*, Koch. This arrives in numbers upon the species of elm that it prefers. I do not yet know whence it comes. Here, therefore, we have Aphides which, cleverer than the botanists, can recognize in the winter trees which the naturalist can only distinguish in summer by their flowers and fruits. Of course I make no attempt to explain such phenomena as these; I do not set up hypotheses, and confine myself to indicating exact facts, which I observe with the greatest possible attention. The problem of the biological evolution of the Aphides of the elm was enunciated more than a century ago; it is now solved.—*Comptes Rendus*, December 31, 1883, p. 1572.

Note on two New California Spiders and their Nests.

The Rev. Dr. McCook presented a small collection of spiders received from Mr. W. G. Wright, San Bernardino, Cal., mailed November 18. One of these came within a nest, and is a Saltigrade spider, probably an *Attus*. The nest is a rare one, and was so happily placed, by the builder, on a branch of sagebrush (*Ephedra antisyphilitica*) that it was preserved intact. It is the only one which Mr. Wright had seen in site. Another nest, which he had no doubt was the same, he had observed torn from its place by some bird, as material for the construction of a bird's-nest.

Nests somewhat similar are habitually made by Pennsylvania Saltigrades upon or among leaves, which shrink up as they die and tear the spinning-work so as to destroy the specimen. The one exhibited was in perfect condition. It is the tent and egg-nest of the species which was alive within it, and the speaker thought to be new. It is a large example, five-eighths inch in body-length, stout, the legs of moderate thickness, the whole animal covered closely with greyish-white hairs, the skin beneath being black. Dr. McCook named the species, provisionally, *Attus opifex*, with a double reference to the discoverer (Mr. Wright) and the admirable housewright qualities of the aranead herself. The nest is externally an egg-shaped mass of white spinning-work, three inches long by two and one-half inches wide. The outer part consists of a mass of fine silken lines crossing in all directions and lashed to the twigs within which it is enclosed. This maze surrounds a sac or cell of thickly-woven sheeted silk, irregularly oval in shape, two inches long by one inch wide, and also attached to the surrounding twigs. At the bottom this cell or tent is pierced by a circular opening, which serves the spider as the door of her domicile. It is the habit of her genus to live and hibernate within such a silken nest. Against one side of the tent within is spun a lenticular cocoon (double convex) of thick white silk, within which the eggs were placed. The young spiders when received had escaped from the cocoon, and occupied the package-box. They are about one-eighth inch long, resembling the mother, but less heavily coated with grey.

This collection also contained three specimens (♀) of the genus *Pucetia*, as defined by Thorell*. This genus belongs to the family Oxyopidæ of the Citigrade spiders, to which it is doubtless properly relegated in spite of certain analogies with the Attoidæ (Saltigrades) on the one hand, and the Philodrominæ (Laterigrades) on the other. Mr. Wright calls them "jumping spiders." Hentz, who describes several species of *Oxyopes*, says that *O. salticus* leaps with more force and vivacity than an *Attus*†. Of *O. viridans* he thinks it possible that the mother carries its young like *Lycosa*. This family of spiders is arboreal in habit, is found on plants, with their legs extended, thus disguising themselves after the manner known as "mimicry," and springing upon their prey. The cocoon is usually conical, surrounded with points, placed in a tent made between leaves drawn together and lashed, and is sometimes of a pale greenish colour. *O. viridans* will make a cocoon suspended in mid-air by threads attached to the external prominences, which she will watch constantly from a neighbouring site. Dr. McCook believed the species presented to be new; the body-length is fourteen millimetres; legs long, tapering, with many long spines. The body is yellow and pale yellow; the cephalothorax striped longitudinally with

* See "On European Spiders," Nova Acta Reg. Soci. Sci. Upsalensis, 3rd ser. vol. vii. p. 196.

† 'Spiders of the United States,' p. 48.

bright red streaks; the abdomen marked above with red bell-shaped and angular patterns, and beneath with red streaks; the sternum red, the legs yellow with red rings at the joints. The species was named *Pucetia aurora*, because of the bright red streaks upon the yellow background, suggesting "the daughter of the dawn."

According to some field-notes forwarded by Mr. Wright since the above was in print, *Pucetia aurora* is rather abundant in a limited locality. The nests are uniformly upon bushes of *Eriogonum corymbosum*, and several specimens of them were sent. The nest is hung from three to four feet from the ground, and, being upon the topmost twigs, is easily seen from a distance. The cocoon is a straw-coloured sphere or ovoid, five-eighths of an inch in diameter. It is covered externally with various pointed rugosities, from which numerous lines extend to the adjoining foliage, and into the maze of right lines which extends below the corymb of the plant upon which all the specimens sent are attached. This retitelarian snare doubtless serves as a temporary home for the young spiders. The cocoon has no suture, the spiderlings escaping by cutting the case, which is thick and closely woven. No floss padding was found inside of the case.

Upon approaching the nest, the mother is usually seen hovering over the young spiders, or guarding a new sack of eggs. She lays two and sometimes three broods on one twig. Sometimes the young ones will be still in the old nest, while the mother is guarding a new bundle of eggs immediately adjoining the old one. In no case were any young ones seen on the mother's back. The mother stays close by her nest. If the spiderlings be hatched, she will, perhaps, drop down a foot or so, if a first effort to capture her be not successful; but will not drop to the ground, unless forced to do so. If guarding her eggs, she must be forcibly separated from the cocoon. The young ones take alarm sooner than their mother; they drop down a few inches—or, at times, two feet—every one on its tiny thread, forming a pretty, swaying fringe. In a few moments, if all is still, they climb up again; but if frightened, will drop to the ground and run. The little ones in such case do not jump.

It is a further interesting fact in so-called "mimicry" that of several examples of *P. aurora* seen by Mr. Wright, one found on a *green* bush was in colour almost wholly green, with scarcely a trace of red; while two found on a hoary-white bush had simulated the white colour of their habitat. The specimens, as described above by Dr. McCook, approach in coloration the prevailing hue of the *Eriogonum* on which they were nested, and he was inclined to think that this is the normal colour of the adult, which is taken on as the animal matures; indeed, as the green and whitish specimens were not sent to him, he would be inclined to think (awaiting further evidence) that those colours may have been due to immature age. At least the tendency to such colours is strong in young spiders. However, the fact of mimicry is not improbable, as Dr. McCook had observed it in our native Laterigrades.

From the same gentleman and locality, Dr. McCook had received a ♀ specimen of *Argiope fasciata*, which is thus located upon the Pacific coast, giving this beautiful and interesting spider a continental distribution.—*Proc. Acad. Nat. Sci. Philad.* 1883, Nov. 27, p. 276.

On an Aerial Alga inhabiting the Bark of the Vine. By M. J. B. Schnetzler.

In the month of April of the present year (1883) there was observed upon numerous vines between Pully and Belmont (Canton de Vaud) a pulverulent matter of a brownish-red colour, which penetrated into the fissures of the periderm. This pulverulent matter is formed by an aerial alga, *Chroolepus umbrinum*, Ktz., or *Trentepohlia umbrina* (Kg.), Born., which is met with upon the bark of various trees, but has not hitherto been mentioned upon that of the vine. This alga contains a very refractive red oil, which diffuses a faint odour of violets; it does not appear to injure the vine, upon which occurs a complete cryptogamic vegetation formed by species of *Oscillaria*, *Nostoc*, and *Pleurococcus*, Confervæ, Mosses, and Lichens (*Physcia ciliaris*, *Pyrenula*, &c.). *Chroolepus umbrinum* is composed of small spherical cells of about 30 μ, forming small curved chains.

When the bark of the vine reddened by *Chroolepus umbrinum* is moistened with water, this same alga is seen very distinctly in the thallus of one of the lichens of the genus *Pyrenula*. It must be remarked, however, that the cells of the alga which occur in the thallus are smaller than those which exist in the air; they form in it very distinct little chains. We observe, moreover, all the transitions between the cells which exist out of the thallus and those which occur more or less deeply buried in it. Around the chaplets and free cells of the *Chroolepus* we sometimes find the filaments of the mycelium of a fungus, which surround them and bind them into small colonies.

The cells of *Chroolepus umbrinum*, which occur either in the free state or immersed in the thallus of *Pyrenula*, often present a green coloration. One can find all the transitions between entirely red cells and others partially or entirely green. This green coloration is met with especially when vine-bark reddened by the free *Chroolepus* is plunged into water. In this latter case we see issuing from some of these cells, which are still red, small ovoid bodies which swim briskly in the water (*zoogonidia* of Wille *).

In a very interesting memoir by M. A. B. Frank † we find some observations precisely analogous to the preceding. It results from them, as we have likewise ascertained, that *Chroolepus umbrinum* may lead a completely free and independent existence, while the same alga occurs with smaller dimensions in the thallus of crustaceous lichens; but when, in consequence of the disaggregation of this thallus, the alga is set free, it multiplies and by degrees resumes its typical form and its normal dimensions.—*Bulletin de la Société Vaudoise des Sciences Naturelles*, sér. 2, vol. xix. no. 89, p. 53.

* Just, Bot. Jahresber. 1878, p. 390.

† "Ueber die biologischen Verhältnisse des Thallus einiger Krustenflechten," in Just, Bot. Jahresber. 1876, p.70.

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XXVII.—*On the Modern Philosophical Conceptions of Life.* By J. J. Woodward, President of the Philosophical Society of Washington *.

I propose to invite your attention this evening to some thoughts on the Modern Philosophical Conceptions of Life. The theme is so large that it would be idle to attempt its systematic treatment in the course of a single evening; nor do I pretend to be in possession of any satisfactory solution of this ancient question, of which I might offer you an abstract or outline, pending the fuller presentation of my results elsewhere. Yet I have ventured to hope that a discussion of some of the considerations involved, and a brief statement of certain views that I have been led to entertain, would not be without interest, and perhaps might prove of actual service, especially to those of you who are engaged in biological pursuits.

Undoubtedly the conception of life most popular at the present time is that which assumes all the phenomena of living beings to be the necessary results of the chemical and physical forces of the universe, and claims or intimates that wherever this has not yet been proven to be the case the evidence will hereafter be forthcoming. This doctrine, which

* From the 'Bulletin of the Philosophical Society, Washington,' 1883.

may conveniently be designated the chemico-physical hypothesis of life, has readily found its way from the speculative writings of philosophers to the rostrums of some of our teachers of chemistry and physics, who boldly declare, in their class-lectures and public addresses, that the forces at work in the inorganic world are fully adequate to explain all the phenomena of living beings, and prophesy that the time is soon coming "when the last vestige of the vital principle as an independent entity shall disappear from the terminology of science" *.

Now most of these gentlemen are not embarrassed by any very definite or detailed knowledge of the physiological and pathological phenomena which a tenable theory of life must be competent to explain, while they do know, or at least ought to know, a great deal of chemistry and physics; the confidence with which they maintain their creed is therefore readily understood. Much more surprising is it to find the same doctrine embraced by numerous zoologists, physiologists, nay, even pathologists, among them men who cannot for a moment be supposed to be unacquainted with the phenomena to be explained, and of whose abilities and reasoning powers it is impossible for me to think or speak otherwise than respectfully. Yet I cannot but believe that they have adopted the chemico-physical hypothesis, not so much because they are really satisfied with it as a scientific explanation of all the phenomena, as because they are unduly biassed in its favour by the utterances of the great philosopher who has done, as I think we will all agree, such good service to biological science by elaborating and popularizing the doctrine of evolution.

It is only natural that such a bias should exist. The discussion of the nature of life, in the case of man at least, has always, and not unreasonably, been conjoined with the discussion of the nature of the soul; and the philosophers who have won higher repute in the latter discussion have always been willing enough to offer solutions of the life-problem, and have never had any difficulty in finding followers even among those whose special lines of investigation might be supposed to impose upon them the duty of independent inquiry into the meaning of life.

Just as it was in the old time with regard to this matter, so it is now. When Galen undertakes to discuss the complex

* George F. Barker, "Some Modern Aspects of the Life Question" (Address as President of the Amer. Assoc. for the Advancement of Science, Boston meeting, August 1880; 'Proceedings,' vol. xxix. part i. p. 23).

phenomena of the Psyche, as manifested by the human species, he openly and continually confesses the extent to which he relies upon the authority of Plato; and when the dicta of the master are such as to require a special effort of faith on the part of the disciple, he honestly exclaims, "Plato indeed appears to be persuaded of this; as for me, whether it be so or not, I am unable to dispute the question with him" *.

In like manner, did they venture to be as frank as Galen was, most of the modern biologists who have adopted the chemico-physical theory of life would, I presume, confess, "As to this matter our opinions are derived from Mr. Herbert Spencer's 'Principles of Biology;' what are we that we should venture to dispute as to questions like these with him?"

Nevertheless in striking contrast to this chemico-physical hypothesis of life, which is to be regarded as the fashionable faith of the hour, there still survives in many quarters, and especially among physicians, a disposition to regard indiscriminately almost all the phenomena of living beings as peculiar manifestations of a vital principle. So strong, indeed, is the faith of some of these modern vitalists, that they seem to shut their eyes to the evidence already in our possession as to the actual participation of known chemical and physical forces in the operations going on within living bodies, and appear almost to resent the willing aid that chemistry and physics afford to the physiological investigator of the present day.

Nay, further than this, in the inevitable reaction that is beginning to make itself felt against the avowed revival of the materialism of Epicurus and Lucretius—for we all know now that the chemico-physical hypothesis of life is not a new induction of modern science, but an ancient Greek speculation reappearing in modern petticoats—that other Greek speculation of the threefold Psyche, the doctrine taught by Plato and Aristotle, and which Galen accepted on their authority, the doctrine of a vegetable, an animal, and a rational soul, a human trinity coexisting in every human being, is once more rehabilitated and finding followers—likely, indeed, as I think, to obtain more followers than perhaps any of you yet suppose. And these followers are by no means confined to metaphysicians or churchmen; they can be found also already among the biologists. It is an English biologist of good repute and of no mean abilities who takes occasion, in a technical biological work published this very year, to express his belief that

* Galen, 'Quod animi mores corporis temperamenta sequantur,' cap. 3 (Kühn's edit. t. iv. p. 772).

the Greek conception of the threefold Psyche "appears to be justified by the light of the science of our own day" *.

For myself I must confess at once that I am quite unable to join either of these opposing camps as a partisan. I cannot accept the more strictly vitalistic views, because I am compelled continually to recognize the operation of purely chemical and physical forces in living beings. On the other hand, there are whole groups of phenomena characteristic of living beings and peculiar to them of which the chemico-physical hypothesis offers no intelligible explanation.

From this point of view the various processes and functions of living beings may indeed be divided into two classes, of which the first may be regarded with more or less certainty as the special results, under special conditions, of the very same forces that operate in the inorganic world; while the second, to which alone I would apply the term vital, are not merely in every respect peculiar to living beings, and hitherto utterly inexplicable by the laws of chemistry and physics, but are so different in character from the phenomena of the inorganic world, that it does not seem rational to attempt to explain them by these laws.

Let me refer briefly to the processes and functions belonging to the first class. Here I place all those more strictly chemical processes by which, within the very substance of vegetable protoplasm, inorganic elements are combined into organic matter, as well as those which produce all the various subsequent transformations, whether in plants or animals, of the organic matter thus prepared. This general conception includes of course, in the case of the higher animals, all the chemical phases of the processes of digestion, assimilation, and tissue-metamorphosis or metabolism, including secretion and excretion; in the case of the lower animals and plants, so much of these several functions as belongs to each species.

Now please to understand that when I say I recognize all the chemical phases of these processes to be the results of the ordinary chemical laws, I do not entertain any mental reservation with regard to the unrestricted application of these laws. I cannot for a moment agree with those physiologists who have imagined the vital principle to thwart or interfere with or counteract these laws in any way. I know indeed that we are far from being as thoroughly acquainted as we may by and by hope to be with the chemical phenomena of living beings; that many of the questions are very difficult, so that as yet, with all our labour, we have obtained but partial or even contradictory results; but I find in this only a reason for further

* St. George Mivart, 'The Cat' (London, 1881), p. 387.

investigation—no logical difficulty of a radical kind. In a general way I recognize that the matter of which living beings are composed is built up of elementary substances belonging to the inorganic world, and that it consists of atoms possessed of the very same properties and obedient to the very same laws as like atoms in inorganic bodies. Yet I confess I find in all this no reason for denying the existence of a vital principle; only I do not figure this principle in my mind as a hostile power interfering in any way with the chemical tendencies of the atoms present; I liken its operations rather to those of the chemist in his laboratory who obtains the results he needs only on the condition of most rigid obedience to chemical laws.

Intimately associated with some of the chemical processes just enumerated are those chemical processes of respiration in which the chemical affinities of the oxygen of the atmosphere are directly or indirectly the means of promoting tissue metamorphosis, as well as of reducing at once to simpler forms some portion of the various complex substances derived from the food. These chemical processes are undoubtedly the chief original sources of the heat and mechanical power manifested by animals. Of course they receive heat also from without by conduction and radiation; but this is a small matter to the heat generated within them; of course, too, mechanical power is continually transformed into heat within the body of animals; but this neither increases nor diminishes the total amount of energy liberated.

I yield my hearty assent to that modern scientific induction * which sees in the potential energy of the complex chemical compounds supplied to animals by their food the essential source of all the actual energy of the body, whether manifested in the form of heat or work. In a general way the reduction of these complex chemical compounds by oxidation into the much simpler ones, urea, carbon dioxide, and water, is the means by which potential is converted into actual energy. In the case of plants, too, the source of any little heat that may be developed under special conditions, and of such sluggish motions as actually occur, is doubtless to be found in the reduction to simpler combinations by oxidation of a part of the organic matter already formed. The chief function of the vegetable world, however, is to build up, by means of the solar energy, those complex and unstable

* First taught by J. R. Mayer, 'Die organische Bewegung in ihrem Zusammenhange mit dem Stoffwechsel: Ein Beitrag zur Naturkunde' (Heilbronn, 1845).

organic compounds that supply the animal world with food. Nevertheless, while I yield my hearty assent to this generalization, and freely admit that it is more than a mere deduction from the general doctrine of the conservation of energy—that, in fact, it affords the most satisfactory explanation yet suggested for a large number of observed phenomena—it is my duty to caution you against the erroneous supposition that any one has ever yet succeeded in affording a rigorous demonstration of the truth of the generalization by an adequate series of actual experiments.

Various attempts have indeed been made of late years to determine experimentally both for animals and for man the potential energy contained in the food of a given period, and the actual energy liberated during the same time in the form of heat and work. I think, however, that all practical physiologists who have looked into the question will agree with me that the numerical results hitherto obtained must be received with the utmost caution *. Difficulties exist on both sides of the problem. It is comparatively easy no doubt to obtain a close approximation to the quantity and composition of the food; but to represent numerically what becomes of it in the body, to deduct correctly what passes through unchanged, and ascertain with reasonable accuracy the amount of carbon dioxide, water, and urea into which the rest is transformed, these are questions which have taxed the utmost resources of investigators, and as to which our knowledge is yet in its infancy.

On the other hand, the direct measurement of the resulting heat and work has hitherto proved still less satisfactory. It would seem to be a very simple thing to place an animal in a calorimeter and measure the heat-units evolved in a given time, as Lavoisier and Laplace attempted to do in the latter part of the last century; and we have been told that "Lavoisier's guinea-pig placed in the calorimeter gave as accurate a return for the energy it had absorbed in its food as any thermic engine would have done" †. But this assertion is not supported by the results of actual experiment. We know now that many precautions, unknown to Lavoisier, must be taken to secure any approach to accuracy in calorimetric experiments with animals; and just as the method is being brought to something like perfection, by arranging for the respiratory process and its influence on the results, and by other neces-

* See, for example, M. Foster, 'Text-book of Physiology' (2nd edit. London, 1878, p. 355).

† Barker, *op. cit. suprà*

sary modifications of the primitive rude attempts *, doubts are beginning to arise as to whether after all the conditions in which the animal is placed in the calorimeter are not so far abnormal as seriously to vitiate the results †; so that, in fact, the most approved numerical expressions of the heat-production of the body to be found in the books are based rather upon calculation of the amount that ought to be produced by the oxidation of an estimated quantity of food than upon actual calorimetric observations.

Nor do we find it any easier when we attempt the actual measurement of the amount of work produced by an animal from a given amount of food. Indeed, in attempting to formulate an equation between the potential energy of the food and the actual amount of heat and work in any given case, we are met with the special difficulty that the animal does not evolve less heat because it is doing work than it does when it is at rest; on the contrary, it actually evolves more heat, consuming for the purpose more food than usual, or, if this is not forthcoming, consuming a part of its own reserve of adipose tissue; so that from this source fresh complications of the problem arise.

The labour and ingenuity with which all these difficulties have been encountered is certainly worthy of the highest praise, and I willingly admit the probably approximate truth of the figures generally in use, say $2\frac{1}{4}$ to $2\frac{3}{4}$ million gramme-degrees as the daily average heat-production of an adult man, and 150,000 to 200,000 metre-kilogrammes as his capacity for daily mechanical work ‡. Nevertheless, these figures are after all only probable approximations, and there still exists, with regard to these questions, a large and inviting field for the application of chemical and physical methods to physiological research.

All the mechanical work done by living beings is effected by means of certain contractions of their soft tissues. The movements of the Amœba, so often described of late years, may be taken as the type of the simplest form of these contractions. Similar movements occur, with more or less activity, in the protoplasm of all young cells, and in the higher animals are strikingly illustrated by the movements of the white corpuscles of the blood and the wandering cells of the connective tissue. In the lowest animal forms these

* See H. Senator, "Unters. über die Wärmebildung und den Stoffwechsel," Archiv für Anat. Phys. und wiss. Med. 1872, S. 1.

† Foster, p. 368, *op. cit. suprà*.

‡ L. Landois, Lehrb. der Phys. des Menschen (Vienna, 1879), S. 402.

simple amœboid movements of the protoplasm are the only movements; but in the higher forms, besides these, certain special contractile tissues make their appearance, by which the chief part of the mechanical work done is effected; these are the striated and unstriated muscular fibres.

On account of the extreme minuteness of the little protoplasmic bodies in which the amœboid movements are manifested, the investigation of the mechanical means by which these movements are effected has not as yet been attempted, although a great mass of details have been accumulated by actual observation with regard to the phenomena themselves and the conditions under which they occur. Very little more has been done with regard to the contractions of the unstriated muscular fibres. The striated muscles, however, have been made the subject of a host of researches; and I suppose the conclusions to which we may ultimately be led by these can be regarded, with but little reservation, as applicable to the function of the unstriated muscles, and also to the simpler amœboid protoplasmic contractions.

Yet, notwithstanding the vast amount of experimental labour and speculative ingenuity that has been lavished since the time of Haller upon the question of the contraction of the striated muscle, it must be confessed, in the honest language of Hermann *, that the problem still mocks our best endeavours. For myself, I am unwilling to believe that the phenomena of muscular contraction, or, indeed, of any of the varieties of protoplasmic contraction by which animals effect mechanical work, will not by and by be fully and satisfactorily explained on chemico-physical principles. I cannot for a moment give my adherence to the dogmatism of those modern vitalists who insist that the contractions of a muscle or of an Amœba are essentially vital phenomena; for this would be to claim that life can create force. But it would be folly to shut our eyes to the circumstance that no chemico-physical explanation of muscular contraction yet offered has been so convincingly supported by facts as to command the universal assent of competent physiologists.

Of the various hypotheses devised to explain muscular contraction, those which regard the phenomena as in some way resulting from electrical disturbances have long enjoyed great popularity. Such of these hypotheses as still survive are based upon the electrical manifestations actually observed in living muscles. It has been pretty generally accepted in accordance with the observations of Du Bois-Reymond, whose

* L. Hermann, Handb. der Phys. Bd. i. Th. 1, S. 242.

brilliant series of experiments in animal electricity* is deservedly renowned, that even quiescent living muscles are in a state of electrical tension. If, for example, a muscle composed of parallel longitudinal fibres be exposed with suitable precautions, and divided near each extremity by a transverse incision, the surface of the muscle will be found to be positive to the cut ends, and if one of a pair of non-polarizable electrodes, connected with a suitable galvanometer, is placed in contact with the surface of the muscle and the other in contact with one of the cut ends, the existence of a current is made manifest. The conditions are, moreover, such that while the maximum effect is produced when the equator of the surface is connected with the centre of one of the cut ends, more or less current will also be manifested whenever any two points of the surface are thus connected with the galvanometer, provided they are not equidistant from the equator. In such cases the point most distant from the equator is always negative. The electromotive force of this natural current of the quiescent muscle varies greatly, but has been found by Du Bois-Reymond to amount sometimes to as much as ·08 Daniell in one of the thigh-muscles of the frog †. In muscles of different form or cut differently from what has just been described the currents are somewhat differently arranged; but the example just given must suffice for my present purpose.

In accordance with the observations of the same investigator, it is claimed that during a muscular contraction the electrical tension diminishes, the normal muscle-current experiences a negative variation, and this occurs in such a way that, as the wave of actual contraction moves along the muscle, which it does, according to the observations of Bernstein and Hermann ‡, with a velocity of about 3 metres per second, it is preceded by a wave of negative variation. This negative variation is indeed so trifling if the muscle contracts but once, that it is difficult to observe it; but when the contractions succeed each other with great rapidity, as in artificially produced tetanus, it may become sufficient to neutralize completely the deflection of the galvanometer due to the current of the quiescent muscle.

But the belief that the electrical currents shown to exist in the

* Emil Du Bois-Reymond, 'Unters. über thierische Elektricität' (Berlin, 1848–60), and 'Gesammelte Abhandl. zur allgemeinen Muskel- und Nervenphysik' (Leipsic, 1875–77).

† Du Bois-Reymond, Ges. Abhandl. Bd. ii. S. 243.

‡ Bernstein, 'Unters. über den Erregungsvorgang im Nerven- und Muskelsysteme' (Heidelberg, 1871); also Du Bois-Reymond's 'Archiv,' 1875, S. 526; Hermann, in Pflüger's 'Archiv,' Bd. x. 1875, S. 48.

quiescent muscles in these experiments exist also in uninjured animals has not remained unchallenged. Since 1867 it has been attacked especially by Hermann*, who has endeavoured to show that these currents are produced only under the special conditions of the experiments, and that there are in reality no natural muscle-currents at all. It was well known that the currents observed in the experiments varied greatly under different circumstances, and it seemed a significant fact that they should be most intense when the muscle was removed from the body and had both ends cut off. If the muscle was removed with its tendinous extremities still attached, the current was usually found to be very feeble or entirely absent, until the ends were well washed in salt and water or dipped in acid. Du Bois-Reymond had explained this by supposing the natural ends of the muscle to be protected by what he called a parelectronomic layer of positive elements that must be removed before the natural current could be made manifest. On the other hand, Hermann has endeavoured to show that the parts injured by the knife or acted on by the salt or acid enter at once into the well-known condition of rigor mortis, and only become negative to the still living portions of the muscle in consequence of this change. That electrical disturbances actually occur in contracting muscles he admits, but endeavours to show that they are due simply to the fact that the changes preceding contraction make the affected part of the muscle negative to every part less modified or wholly unaltered. Hence if an uninjured muscle be caused, under proper precautions, to contract simultaneously in all its parts, it will be found that the contraction is wholly unaccompanied by any muscle-current †.

Observations that appear to support these views of Hermann have been brought forward by Engelmann ‡. On the other hand, Du Bois-Reymond has defended his views with vigour, and sharply criticized, of course, the labours and logic of his assailant §. I need not at present express any opinion as to the merits of this voluminous controversy. It is enough for my purpose to indicate the questions at issue as sufficiently important and uncertain to be well worthy of independent experimental criticism.

Suppose, however, this criticism should result in showing

* L. Hermann, 'Weitere Unters. zur Phys. der Muskeln und Nerven' (Berlin, 1867); also Handb. der Phys. Bd. i. Th. 1 (Leipsic, 1879), S. 192 *et seq.*

† Hermann, Handb. der Phys. Bd. i. Th. 1, S. 215.

‡ Engelmann, Pflüger's 'Archiv,' Bd. xv. (1877), S. 116 *et seq.*

§ Du Bois-Reymond, Ges. Abhandl. Bd. ii. S. 319 *et seq.*

that Hermann is wholly in the wrong and that the muscle-currents observed by Du Bois-Reymond really exist in healthy muscles. How then shall these currents explain the phenomena of muscular contraction? I presume that no physiologist of the present day is misled by the superficial comparison which Mayer and Amici were led by their microscopical studies of the muscles of insects to make between the striated muscular fibre and a voltaic pile *. But the molecular theory by which Du Bois-Reymond has endeavoured to explain his natural muscle-currents and their negative variation would appear to open up an inexhaustible mine of speculative possibilities for those who are inclined to speculate.

Yet the old experiment of Schwann † has always been a stumbling-block in the way of any theory that would explain muscular contraction by the action of a force which must increase inversely as the square of the distance between the molecules, for the force of the contraction, as it actually occurs, diminishes as the muscle shortens; and hence we find so good a physiologist as Radcliffe ‡ reviving in a modified form the old hypothesis of Matteucci §, in accordance with which the electrical tension of the fibre in the state of rest causes a mutual repulsion of the molecules, and so elongates the muscle, while the contraction is merely the effect of the elasticity of the tissue, which asserts itself so soon as the repulsive force is diminished by the negative variation that precedes contraction.

In consequence of these and other difficulties many physiologists are beginning to regard the electrical phenomena as subordinate accidents of the chemical processes that go on in muscle, and endeavour to explain muscular contraction as resulting directly from these chemical processes themselves. Arthur Gamgee || has adopted as most probable the chemical hypothesis of Hermann ¶. This assumes the contraction to result from the decomposition of a complex nitrogenous compound supposed to be contained in the muscular tissue, and

* Mayer, Müller's 'Archiv,' 1854, S. 214; Amici (1858), translation in Virchow's 'Archiv,' Bd. xvi. 1859, S. 414.

† Schwann, in Müller's Handb. der Phys. 1837, Bd. ii. S. 59.

‡ C. B. Radcliffe, 'Dynamics of Nerve and Muscle' (London, 1871).

§ Matteucci, 'Lectures on the Physical Phenomena of Living Beings' (translated by J. Pereira), London, 1847, p. 333.

|| Arthur Gamgee, 'A Text-Book of the Physical Chemistry of the Animal Body,' vol. i. (London, 1881), p. 418.

¶ L. Hermann, 'Grundriss der Phys. des Menschen,' 5te Aufl. 1874, S. 231.

named inogen. During contraction inogen breaks down into carbon dioxide, lactic acid (Fleischmilchsäure), and gelatinous myosin. The rearrangement of molecules necessary to produce the latter body determines the contraction. Subsequently the gelatinous myosin combines with the necessary materials furnished by the blood, and becomes inogen again. This decomposition and recomposition goes on also while the muscle is at rest; but as then the gelatinous myosin is reconverted into inogen as rapidly as it is formed, no contraction results.

Du Bois-Reymond declares all this to be merely unsupported hypothesis *. Gamgee himself admits that it is after all not very clear why the gelatinous myosin should contract. Michael Foster †, who wholly rejects this particular chemical hypothesis, nevertheless seems quite sure that the true explanation will be found to be a chemical one. He insists that muscular contraction is essentially a translocation of molecules, and declares that whatever the exact way in which this translocation is effected may be, it is fundamentally the result of a chemical change, or, as he describes it, "an explosive decomposition of certain parts of the muscle-substance."

The purpose I have in view does not require, fortunately, that I should attempt to decide whether these more purely chemical theories of muscular contraction or the more purely electrical theories are best entitled to confidence. My object has been effected if I have impressed you with the fact that wide differences of opinion still exist as to the nature of the process, and that further investigation is indispensable for the settlement of existing controversies.

The subject thus briefly discussed brings us naturally to the consideration of the nature of the action of the motor nerves, by which, in all animals possessed of a muscular and nervous system, the contraction of the muscles is regulated and determined.

The hypothesis which identifies the nervous currents with electricity was propounded in the posthumous work of Hausen‡ in 1743, and, notwithstanding all the difficulties and objections it has encountered, still survives in a modified form in many contemporaneous minds. Those who hold to this view appeal in its support to the electrical phenomena actually observed in nerves in accordance with the investigations of

* Du Bois-Reymond, Ges. Abh. Bd. ii. S. 320.

† Foster, *op. cit.* p. 79 *et seq.*

‡ C. A. Hausen, 'Novi profectus in historia electricitatis' (Leipsic, 1743). I cite from Du Bois-Reymond, 'Unters. über thierische Elektricität,' Bd. ii. (Berlin, 1849), Th. i. S. 211.

Du Bois-Reymond. These observations have long been widely accepted as conclusive proof that natural currents exist in the quiescent nerve of the same general character as those attributed to the quiescent muscle, which I outlined a few minutes ago. The electromotive force of this current was found by Du Bois-Reymond * to be equal to ·022 Daniell in the sciatic nerve of the frog. When a nervous impulse passes along the nerve, the natural current is diminished; it experiences a negative variation, which, according to Bernstein †, when the impulse results from a very potent stimulation, may more than neutralize the natural current. The same physiologist has shown that this negative variation moves along the nerves of the frog at the rate of 28 metres per second, that is, at the same rate as the nervous impulse itself, as determined without reference to the electrical phenomena.

As in the case of the muscle-currents, these phenomena have been differently interpreted by Hermann ‡, who denies the existence of any natural nerve-current in uninjured nerves, and ascribes those observed in the experiments to the circumstance that the parts of the nerve dead or dying, in consequence of the section, become negative to the living nerve. The negative variation produced by the stimulation of a nerve he explains by assuming that the stimulated part of the nerve becomes, in consequence of the changes resulting from the stimulation, negative to the unstimulated parts. I will not attempt to enter to-night into the merits of the controversy still in progress with regard to this question, nor will I pause to discuss the exceedingly curious and interesting phenomena of electrotonus §, concerning which I will only say that the question has even been raised by Radcliffe as to how far these phenomena are peculiar to nerves, and how far they may be regarded as mere phenomena of the electrical currents employed, which would be equally manifested under similar circumstances if a wet string or other bad conductor should be substituted for the nerve ||.

However these disputes may be ultimately decided, whatever the actual facts with regard to the electrical manifestations in nerves at rest or in action may ultimately prove to

* Du Bois-Reymond, Ges. Abh. Bd. ii. S. 250.

† Bernstein, *op. cit. suprà.*

‡ Hermann, *loc. cit. suprà*, note *, p. 242; also Handb. der Phys. Bd. ii. Th. 1 (Leipsic, 1879), S. 144 *et seq.*

§ See especially Du Bois-Reymond, 'Unters. Bd. ii. Th. 1, S. 289, and Pflüger, 'Unters. über die Physiologie des Electrotonus' (Berlin, 1859). An excellent summary of the observations (with the literature) is given by Hermann, 'Handb. der Physiologie,' Bd. ii. Th. 1, S. 157 *et seq.*

|| Radcliffe, p. 74 *et seq.*, *op. cit. suprà.*

be, there is a group of easily repeated elementary experiments which seem to show pretty distinctly that whatever the nervous impulse may be it is not merely an electrical current.

It was known already when Haller wrote * that a string tied tightly around a nerve, although it in no wise interferes with the passage of electrical currents, puts a speedy end to the transmission of nervous impulses. With this old experimental difficulty uncontradicted, it seems strange that any one should declare at the present time that "the main objection raised to the electrical character of nerve energy is based upon its slow propagation" †. In fact this latter objection is altogether a subordinate difficulty which may perhaps be entirely explained away; the main experimental objection does not relate to the velocity, but to the conditions of the propagation of the nervous impulse. If instead of tying a string around it the nerve be merely pinched or bruised well with a pair of forceps, so as to destroy its delicate organic texture, if it be compressed tightly by a tiny metallic clamp, if it be divided by a sharp knife, and the cut ends brought nicely into contact, or brought into contact with the extremities of a piece of copper wire, it will still conduct electrical currents as well as ever, but can no longer transmit the nervous impulse. So, too, there are certain poisons, such as the woorara, which completely destroy the capacity of the nerve for transmitting nervous impulses without in the least diminishing its conductivity for electricity ‡.

In view of these and other practical difficulties, the best instructed modern physiologists no longer attempt to identify the nervous impulse with the electrical phenomena by which it is accompanied. Du Bois-Reymond himself has suggested that the nervous agent "in all probability is some internal motion, perhaps even some chemical change, of the substance itself contained in the nerve-tubes, spreading along the tubes" §. Herbert Spencer came to the conclusion that "nervous stimulations and discharges consist of waves of molecular change" || flowing

* A. von Haller, 'Elementa Physiologiæ,' lib. x. sect. viii. § 15, t. iv. (Lausanne, 1762), p. 380. He cites as authority the essay of Le Cat, crowned by the Berlin Academy in 1753. [We have in the S. G. O. Library the Berlin edition of 1765, 'Traité de l'existence &c. du fluide des nerfs,' &c.]

† Barker, p. 8, *op. cit. suprà.*

‡ Claude Bernard, 'Leçons sur la Phys. et la Path. du Système nerveux' (Paris, 1858), t. i. pp. 157 and 224.

§ Translation of a lecture given by E. Du Bois-Reymond at the Royal Institution, London, in Appendix no. 1 of H. Bence Jones's 'Croonian Lectures on Matter and Force' (London, 1868), p. 130.

|| Herbert Spencer, 'The Principles of Psychology,' vol. i. (New York, 1871), p. 95. Compare also his 'Principles of Biology,' vol. ii. (New York, 1867), p. 346 *et seq.*

through the nerve-fibres; and I suppose that most physiologists at the present time think of the nervous current in some such way as this. Even those who attach most importance to the electrical phenomena will, I take it, agree with Michael Foster that these "are in reality tokens of molecular changes in the tissue much more complex than those necessary for the propagation of a mere electrical current" *.

We do not, however, as yet possess any sufficient foundation of facts on which to build a reasonable hypothesis as to the nature of the molecular disturbances that accompany a nervous impulse. The labours of the physiological chemists have taught us nothing with regard to the changes that go on, except that the axis-cylinder, which in the inactive living nerve is alkaline, becomes acid after long-continued activity or after death †. We can measure the velocity with which the impulse travels, we can study the conditions under which it arises, we can believe, as I certainly do, that it will ultimately receive a chemico-physical explanation; but its real nature we do not yet know.

So far as we can ascertain, the phenomena of the conduction of nervous impulses by the sensitive nerves are so similar to those of the conduction of motor impulses that any explanation ultimately adopted for the one will probably apply to the other also. When, however, we ascend to the study of the nervous centres, by which sensitive and motor nerves are connected together, and attempt the interpretation of the complex functions of nerve-cell, ganglion, spinal cord, and brain, we find that none of the hypotheses hitherto brought forward to explain the observed phenomena repose on any defensible chemico-physical basis.

I cannot of course undertake to give to-night even the most meagre outline of the wondrous mechanism which physiological experiments show must exist. That reflex actions, co-ordinated muscular movements, and all the complex phenomena of this class do depend upon a wonderfully complex mechanism, and occur in strict accordance with the ordinary chemical and physical laws, I do not for a moment doubt, and I cordially invite the cooperation of the chemists and physicists to aid the physiologists in the explanation of this mechanism, for we stand only upon the threshold as yet.

If now we turn from the more general discussion of muscular contraction and nervous action to the consideration of the several functions carried on in animals by means of special arrangements of the muscular and nervous systems,

* Foster, p. 79, *op. cit. suprà.*
† A Gamgee, p. 447, *op. cit. suprà.*

we continually encounter the preponderating influence of purely physical laws. The introduction of air into the lungs of breathing animals and its expulsion thence is effected in a purely mechanical way, while the exchange of the carbon dioxide of the blood with the oxygen of the inspired air occurs in strict obedience to the laws of the diffusion of gases.

The ordinary laws of hydraulics govern the circulation of the blood and lymph, and all the complex visible motions of the body are executed in accordance with the ordinary laws of mechanics; nor is it at all necessary for me to insist upon the purely physical nature of the operations of the organs of the special senses, conspicuously the eye and the ear. For example, so far as concerns the means by which images of external objects are formed sharply upon the retina, the eye is as purely a physical instrument as the telescope or the microscope. But I need not dwell upon this group of phenomena, because the importance of the rôle of the ordinary physical laws in this domain is conceded, I suppose, by the extremest of the vitalists of the present day.

We see, therefore, that, with regard to a large part of the phenomena of living beings, there are grounds for affirming either that they have already been satisfactorily explained by a reference to established chemical and physical laws, or at least that they are of such a character that it is reasonable to hope they may be thus explained at some future time. Is it possible, then, to return, as some have done of late years, to the old speculation of Des Cartes, and look upon living beings as mere machines? To do so it will not suffice to image to yourselves ordinary machines in which fuel yields force. To satisfy the chemico-physical hypothesis of life you must suppose machines that build themselves, repair themselves, and direct from time to time new applications of their energy in accordance with changes in the environment—nay, more, machines that accouple themselves together, breeding little machines of the same kind, that grow by and by to resemble their parents, and all this self-directed, without any engineer. But even Des Cartes required an engineer—the soul—to run his man-machine; and the logic which compelled him to this view applies just as forcibly to all the modern machine-conceptions of living beings.

I have already asserted that there are whole groups of phenomena characteristic of living beings, and peculiar to them, which cannot be intelligently explained as the mere resultants of the operation of the chemical and physical forces of the universe. These phenomena I refer—I avow it without hesitation—to the operations of a vital principle, in the existence of which I believe as firmly as I believe in the existence of force, although I do not know its nature any more than I know the nature of force. If, for convenience, at any time I compare the living body to a machine, I must compare the vital principle to the engineer; it is the director, the manager if you will, but it does not supply the force that does any part of the work. Let us consider, then, in the remainder of this discourse the phenomena which indicate the guidance of the vital principle.

The first group of phenomena belonging to this second class are those forced upon our attention whenever we attempt to study the question of the origin of life. It has seemed to some of our contemporaries that, in accordance with the doctrine of evolution, as deduced by Mr. Herbert Spencer from the great truth of the persistence of force, life ought always to arise spontaneously out of inorganic matter whenever the necessary materials and other conditions of life are brought together. Indeed, if there be nothing more or other in life than force, I confess I do not understand how this conclusion can be logically escaped; and yet when we come to interrogate nature we find that, in point of fact, things do not happen so.

The sun may stream all the enormous energy of his rays upon the slime of the Nile, but he generates no monsters; nay, not even a bacterium, except in the presence and under the direction of pre-existing life. Our biological knowledge has so far advanced that it is easy for us to get together mixtures of matter, for the most part derived from pre-existing living beings, which are peculiarly well fitted to supply the materials needed for the building up of a variety of low forms of life; and the extent of our present knowledge of the conditions favourable to the development of these low forms of life is shown by the rapidity with which they do develop from a few individuals to countless millions, if only a few individuals are introduced as parents into our flasks and brood-ovens. The species to which the countless progeny belongs, depends always upon the species of the parents we introduced by design or accident; and if parents of several species are introduced we may imitate on a tiny scale the great struggle for existence, and witness the survival of the fittest. Never, however, has the spontaneous generation, out of inorganic matter, of a single living form been yet observed.

Speculative considerations have, indeed, from time to time led certain enthusiasts to desire earnestly that it might be observed; and when we consider, on the one hand, the influence of pre-existing bias, and, on the other, the intricacy of some of the experimental processes in question, it is by no means necessary to charge dishonesty upon those who, from time to time, have actually fancied that their desires have been realized to the extent of the spontaneous generation of bacteria at least. When we consider the immense development of the trade in canned food, which could not exist for a single summer's day if these experimenters were not mistaken, it will be seen how little need there was for renewed scientific experiment to refute their conclusions; but it is a noteworthy fact that among those who have contributed most by exact research to recent scientific demonstrations of the truth that life never arises except from pre-existing life, are to be found some of the most earnest and eloquent advocates not merely of the doctrines of evolution, but of its supposed corollary, the chemico-physical hypothesis of life.

I sympathize heartily with those who, recognizing that the supposition of the spontaneous origin of life on our globe is flatly contradicted by the facts of science, have endeavoured to escape the difficulty by imagining the earliest parent living forms to have been brought to our earth on the surface of meteoric stones or other cosmical bodies. This hypothesis, put forward originally on purely theoretical grounds, has recently acquired a certain degree of support from the published observations of Hahn and Weinland*, who believe they have recognized the remains of humble coralline forms in thin sections of meteoric stones collected in Hungary. Yet these observations, if indeed they should prove to be correct, would rather afford indications of the existence of life in other worlds than ours, than show that living forms could survive the high temperature to which such cosmical masses must be exposed during their transit through our atmosphere; and even should we find reasons for ultimately adopting this hypothesis, we should not have solved the problem of the origin of life, but only removed it entirely beyond the domain of further scientific investigation.

If, however, we reject this view, and still mean to support the chemico-physical hypothesis of life, we shall have to resort to a still more improbable supposition. We shall have to suppose that although in the present order of things life can only arise out of pre-existing life, the order of things was at some past time so far different that life could then arise out of inorganic matter—a supposition which implies an instability in the course of nature that is contradicted by all the teachings of science.

* O. Hahn, 'Die Meteorite und ihre Organismen,' Tübingen, 1881. I cite the Journ. of the Royal Microsc. Soc. October 1881, p. 723.

I willingly admit that, in view of our present scientific notions of the cosmogony, it is impossible to believe that life always existed upon this planet. I willingly admit that life on the earth must have had a beginning in time. But we do not know how it began. Let us honestly confess our ignorance. I declare to you I think the old Hebrew belief, that life began by a creative act of the Universal Mind, has quite as good claims to be regarded as a scientific hypothesis as the speculation that inorganic matter ever became living by virtue of its own forces merely.

If we turn now to the consideration of the processes of growth, we shall find additional reasons for believing in the existence of a vital principle. Let us consider first, in the most general way, the conditions under which those strictly chemical processes occur, to which I have already alluded, and by which the inorganic atoms are combined into organic matter. I repeat it, I do not for a moment question that the actual force by which these processes are compelled exists in the solar rays, and that it is, after all, the solar energy thus stored up in the vegetable protoplasm and its products that supplies, by its subsequent liberation, all the force manifested by living beings. Yet, let me beg you to observe that in all the myriads of years during which the solar energy has streamed upon the earth, that energy has never, on any occasion that we know of, determined the combination of inorganic atoms into organic matter, except within the substance of already living protoplasm. The water and carbon dioxide and ammonia in the atmosphere and in the soil come into contact with each other, within the substance of porous inorganic clods on the surface of the soil, much as they do in the substance of protoplasm, and the equal sun warms both alike; but in the clod they remain water, carbon dioxide, and ammonia; in the protoplasm, provided only that it is living protoplasm, they combine into starch or oil, or even into protoplasm itself. The essential condition, then, of this storing up of the solar energy for the subsequent use of living beings is the presence of life, and in these fundamental operations the mighty force of the sun acts, in the fullest sense of the words, the part of the servant of life.

The view thus suggested, that we have here to do with something more than the mere operation of the inorganic forces, is still further strengthened when we come to consider more in detail the phenomena of the growth of living beings, whether plants or animals. The better we become acquainted with these phenomena the more fully we become convinced that we have to do with processes for which the inorganic world affords no parallel.

Linnæus, indeed, declared, "lapides crescunt," using the very same phrase which he applied also to plants and animals*. But it is impossible to maintain this assertion without adopting the most superficial view of the growth of living beings, and defining the process to consist merely in increase of size. That this should have appeared reasonable in the time of Linnæus need excite no surprise; but it seems strange to find so astute a thinker as Mr. Herbert Spencer repeating the old fallacy in the first chapter of his 'Inductions of Biology,' and declaring, "Crystals grow, and often far more rapidly than living bodies"†. Then, after instancing the formation of geological strata by the deposit of detritus from water, as well as the formation of crystals in solutions, as examples of growth in the inorganic world, he asks: "Is not the growth of an organism a substantially similar process?" and adds, "Around a plant there exist certain elements that are like the elements which form its substance, and its increase in size is effected by continually integrating these surrounding like elements with itself; nor does the animal fundamentally differ in this respect from the plant or the crystal."

Now, as opposed to this, I must express my belief that the more we know of the actual details of the process of growth in plants and animals the more clearly will it be seen that this process does differ so fundamentally from that by which a crystal is formed and increases in size, or from any increase in size of inorganic bodies, that the same scientific term cannot with any propriety be applied to both, however long popular usage may have given to both a common name. When inorganic bodies increase in size the additional atoms are deposited on their external surfaces; or, if a fluid, after penetrating the interstices of some porous body, deposits there any material held in solution, the mass, indeed, is increased thereby, but not the size. When, however, vegetable protoplasm grows, it does not merely integrate with itself certain elements around it like the elements which form its substance; the needed elements exist in compounds quite unlike itself, and it combines them together into protoplasm in all parts

* "Lapides crescunt, Vegetabilia crescunt et vivunt, Animalia crescunt, vivunt et sentiunt." This phrase occurs in the first edition of the 'Systema Naturæ,' Leyden, 1735. I cite the reprint of Fée, Paris, 1830, p. 3, as well as the second Stockholm edition, 1740, p. 76. The expression is replaced in the later editions by more guarded language.

† Herbert Spencer, 'The Principles of Biology,' vol. i. New York, 1866, p. 107.

of its mass, so that it grows by a process of intussusception wholly unlike anything that occurs in the inorganic world. In the case of animal protoplasm, the mode of growth by intussusception is the same, but the capability of combining together mere inorganic elements into its own substance is lost; and, besides these, a certain amount of pre-existing vegetable or animal protoplasm must be present in the food, or growth will not go on.

In both cases, when the growth has proceeded to a certain extent—within certain definite limits—a new characteristic phenomenon occurs in a growing mass of vegetable or animal protoplasm; it multiplies by division, its whole mass participating in the act, in accordance with one or other of a few definite methods. This process is repeated again and again. The progeny may separate, without modification, as independent forms, or, as in the case of the more complex organisms, they may cohere together, and the process culminates by groups of them undergoing certain definite and peculiar transformations, after which further multiplication becomes rare or ceases altogether, and the growth of the complex organism is thus limited.

I cannot, of course, attempt this evening to describe all the known details of the progress of growth which I have thus hastily sketched; to give you a really satisfactory account of them would require a series of lectures. But I do not hesitate to say that the more fully you know these details the more unscientific you will think the attempt to class them as in any way similar to the circumstance that inorganic crystalline compounds seem "each to have a size that is not usually exceeded without a tendency arising to form new crystals, rather than to increase the old." It is, at the best, a waste of words to attempt to explain complex phenomena by comparing them to simpler ones which are fundamentally unlike them.

I have but now referred to a process by which, in the growth of the more complex living beings, the small primitive protoplasmic mass, out of which each individual arises, subdivides and produces a numerous brood of protoplasmic masses, at first closely resembling the parent mass, but after a time differing from it more and more, and finally undergoing transformations into definite and peculiar forms. This process, which does not take place in any disorderly manner, but in a very characteristic and definite way in each individual form, is designated by the term development. In point of fact, so far as it consists in the mere growth and multiplication of the individual elements that compose the organism, and the increase in size of the organism itself on account of these processes, it is properly designated by the term growth. In so far, however, as the individual elements are differentiated, and the wonderful architecture of the living being, with its organs and systems, is completed thereby, it is properly designated by the term development.

Nothing like the process of development as thus defined exists in the inorganic world, and in all the attempts at such a comparison that it has been my fortune to meet with, the most fundamental facts of the development of living beings have been persistently ignored. Among these fundamental facts I invite your attention especially to the circumstance that there is something in the microscopic mass of protoplasm, out of which, even in the case of the highest and most complex living beings, each individual arises, that goes even further in determining the direction in which the individual shall develop than the pabulum, or environment, or all the mighty chemical and physical forces that are brought into play as the process goes on. In a word, the individual develops after the pattern of its parent, or not even all the solar energy can compel it to develop it at all.

We are thus brought face to face with the facts of sexual generation, and especially of heredity, with all their wide bearings on the great biological questions of natural selection and the origin of species. Into the details of these large questions the limits of the hour will not permit me to enter. Could I take time to do so, I am satisfied that at every step I should be able to collect for you additional evidence of the existence of a vital principle. Still, I regret this the less because most of you, I think, are so familiar with the modern literature of these subjects, and especially with the admirable writings of Mr. Darwin, that I feel sure, if I can succeed in giving you a clear outline of my views, much that I should say, had I time, will suggest itself to your own minds. In a general way, however, when we study, in the history of life upon this globe, the double phenomena of long-continued persistence of type, and of slow variation continually occurring, we shall find that almost all biologists, whatever their theory of life, explain these phenomena on the one hand by heredity, on the other by the sensibility of the organism to the influence of the environment.

Both heredity and the influence of the environment may be very conveniently studied in those simplest organisms in which each individual consists of a single minute mass of naked protoplasm, as in certain rhizopods, for example, the Amœba. These tiny creatures produce a progeny which preserves the parental type as closely as is done by the offspring of the higher animals. Their sensibility to the influence of the environment is manifested in several ways. They grow, that is they appropriate materials from the environment, in the way I have already specified; they manifest automatic movements, that is, on encountering food, obstacles, or other disturbing external circumstances, movements result the direction and energy of which are in no wise determined by the character or force of the external influences, or, as they may be conveniently termed, the stimuli by which these movements are provoked; and finally, simultaneously with the process of growth, a certain metamorphosis, or metabolism, of the protoplasm is continually going on, resulting in the formation of excrementitious substances which are continually being excreted.

The processes of growth and metabolism exhibit different degrees of intensity in accordance with variations of the environment; and whatever physical theory of the mode in which the protoplasmic motions are produced we may adopt, the mechanical force manifested can only be supposed to proceed from the decomposition of a part of the protoplasm itself into simpler compounds, that is, from a particular kind of metabolism. Hence you will, I think, be quite prepared to hear me speak of all the circumstances in the environment that so act upon living protoplasm as to increase its growth or metabolism as stimuli, and of the property of living protoplasm by which all its responses to stimuli are guided as irritability, instead of limiting these terms to the phenomena of automatic movement only, as was formerly done. This irritability of living protoplasm determines the direction in which its internal forces shall be manifested. Speaking of it as I do, perhaps you would wish me to call it sensibility rather than irritability; and I do not know that I should object very strenuously to any one who wished to do this. But however you may name it, it is this vital property of all living protoplasm that produces the sensibility to changes in the environment, which has been the main factor in the gradual evolution, during the ages, of the highest and most complex from the simplest and lowest living forms.

Against this view it has been urged with much ingenuity that protoplasm is the material substratum of life, and life merely a property of protoplasm; that is, if the words have any meaning at all, that life is the resultant only of the forces inherent in the inorganic atoms of which the protoplasm is built up. Now, in the first place, no one has ever yet been able to show, by any conceivable synthesis, how the forces known to belong to the several kinds of inorganic atoms, of which protoplasm is composed, could by their combination, produce the characteristic phenomena of living protoplasm, namely, the phenomena of irritability, as I have just described them. But, in the second place, this speculation appears to be pretty flatly contradicted by the circumstance that, although protoplasm can only be formed within the substance of previously existing living protoplasm, it can continue to exist, it does continue to exist as protoplasm after it has ceased to live. Not merely can it persist for a time without chemical change as dead protoplasm, it can subsequently serve as food and be reconverted into living protoplasm once more. Bear in mind, however, that this change can only be effected within the substance of the living protoplasm of the animal that assimilates this food. It is not effected by the chemistry of digestion; that merely makes peptone of the protoplasm—merely makes it soluble enough to pass into the substance of the protoplasmic masses that are to appropriate it. These considerations, then, would seem to show that the material, protoplasm, cannot be rightly believed to be of itself the cause and essence of life.

If I should pause here, it seems to me that I should have brought forward adequate reasons for believing in the existence of a vital principle. But I cannot pause here. Beyond and above all this there is another great group of phenomena peculiar to living beings—a group of phenomena concerning which, in my own individuality, I have knowledge at least as positive as any I possess of the existence of force, and which I am led, by a logic quite as convincing as that by which any general proposition with regard to the external world is proven, to believe exists in like kind and degree in the case of my fellow-man. I refer to the phenomena of the perceiving, emotional, will-full, reasoning human mind. Into the argument that makes it highly probable that a similar but less and less perfect mind exists in the animal world, and identifies with mind the sensibility of the lowest animal forms, and even that of vegetable protoplasm, I will not attempt to enter to-night. Mr. Herbert Spencer himself has presented this view with so much ingenuity, that, without committing myself to an approval of all his details, I must content myself by referring you to his writings for one of the best discussions of this matter. It will be sufficient for my present purpose to close this discourse by the presentation of a few considerations in relation to mind as it exists in man.

For myself I know mind only as a manifestation of life, if, indeed, it is not the essence of life. But the old doctrine of Epicurus, handed down to us in the poem of Lucretius, that in some way or fashion mind is produced by the clashing together of the atoms, has been boldly revived of late years, and transmuted into a form more plausible to modern thought, although just as unsupported by any actual knowledge of facts.

No one has done this more boldly or more cleverly than Mr. Herbert Spencer has done in his 'First Principles,' and of course you are all familiar with the ingenious argument, in favour of this view, which runs through that masterly work. It would be, from many points of view, profitable, but it would be a very laborious task, to attempt the critical discussion of his argument. It must suffice, for my present purpose, to point out that two of the fundamental assumptions upon which that argument is based are wholly undemonstrated. The first assumption is, that mind is itself a force *; the second, that mind cannot be conscious of itself, but only of the external world †.

If I could bring myself to believe that mind is, in any proper sense of the word, a force, and that such popular metaphorical expressions as mental force or mental energy accurately described the phenomena, I should certainly expect to find at least some shadow of proof for Mr. Herbert Spencer's assertion that mental operations fall within the great generalization of the correlation and equivalence of the forces. On the contrary, however, you will find, on reading his lucid periods, that his whole argument relates to those physical conditions in the organs of sense and in the muscular and nervous systems which are the antecedents of perception—which are, in fact, the things really perceived—and in no sense constitute the perceiving mind. Between strictly mental phenomena and the physical forces no one has as yet even attempted to establish a numerical equivalent; nay, more, the correlation of thought with the physical forces is not only undemonstrated, it is utterly unthinkable. You can conceive several different ways, it matters not whether true or false, in which the motions we know as heat might be converted into those we know as light, and so on with the other physical forces; but you cannot represent mentally any intelligible scheme by which any of the physical forces can be converted into the simplest or most elementary thought.

As to the question of self-consciousness, it seems as if the great philosopher were reasoning in a circle. He first assumes that the fundamental condition of all consciousness is the antithesis between subject and object,—which is true only

* Herbert Spencer, 'First Principles,' Amer. Ed. New York, 1864, p. 274.

† Id. *op. cit.* p. 65 *et seq.*

with regard to consciousness of perception, the form of consciousness by which we become acquainted with the non ego, —and then he concludes that there can be no consciousness of the ego because it cannot fulfil these conditions. That is, in a word, he denies consciousness of the ego, because it is not consciousness of the non ego. Really it appears to me that, as against such a philosophy as this it is not amiss to appeal to "the unsophisticated sense of mankind," of which Mr. Mansel speaks*. But there is fortunately a better philosophy than this—a philosophy which recognizes the validity of the mind's self-consciousness as at least fully equal to the validity of its consciousness of the conditions of the body by which it obtains a knowledge of the external world. By this self-consciousness I know, with a certainty which no doubt can ever disturb, that I have a mind; and by rightly applying my reasoning powers to the data of my self-consciousness, I can learn much that will be useful to me with regard to my mental processes and the methods of employing them. But here I have to stop. I can learn nothing, whether by consciousness or by reasoning, with regard to the real nature of my conscious mind, and however much it may long for immortality, neither philosophy nor science affords any foundation of proof upon which it might build its hopes.

I have already said that I know mind only as a manifestation of life. Its operations are intimately connected with the chemical and physical phenomena of living beings, and it exercises over them a certain directing influence, the nature of which we do not understand. The obedience of our voluntary muscular actions to the mandates of the guiding will is a familiar illustration of this directing influence. On the other hand, all the knowledge of the external world on which the mind exerts its reasoning power reaches it through the organs of sense and the nervous system. Indeed, our studies of the phenomena of sensation compel us to conclude that what our mind really perceives, when it takes cognizance of the external world, is merely the ever-changing panorama of our own cerebral states. It should be anticipated therefore that disturbed or morbid conditions of the brain would lead to irregular or disorderly mental operations; and the circumstance that this really happens affords no better proof of the materiality of thought than is afforded by the circumstances of our ordinary normal thought.

So, too, since the cerebral changes, which the mind perceives, are themselves of a purely chemico-physical nature, it should be anticipated that, like the metabolic processes in

* As cited by Mr. Herbert Spencer, *loc. cit.* last note.

other tissues, they would be accompanied by an increased excretion of characteristic waste-products, by evolution of heat and by afflux of blood. Experimental investigation has been directed to each of these points, and some important observations have no doubt been made; but much of the testimony is conflicting, and our knowledge is still so incomplete that further inquiry in each direction is greatly to be desired.

This is particularly the case with regard to the chemical questions connected with the metabolism of the brain. In the first place, our knowledge of the chemical composition of brain-substance is still in its infancy. The view that its characteristic ingredient is the phosphorized nitrogenous body described in 1865 by Liebreich under the name of protagon has been strongly controverted by Diaconow, Hoppe-Seyler, and Thudicum, while recently it has been reaffirmed by Gamgee and Blakenhorn*. But even should this view turn out to be well founded, we have yet every thing to learn with regard to the transformations protagon undergoes during functional activity, and the nature of the resulting waste products.

Long before Liebreich announced the existence of protagon, however, the attention of the physiological chemists had been directed to the prominence of phosphorus as an element in the composition of the cerebral substance, and it had been suggested that a part of the phosphoric acid excreted in the urine might be derived from the metabolism of the brain. As early as 1846 Bence Jones † had observed an excess of phosphatic salts in the urine during certain brain-diseases, notably acute inflammations; and an observation published in 1853 by Mosler ‡ appeared to indicate that a similar excess followed intellectual activity.

Byasson [1868] in his essay on the relation between cerebral activity and the composition of the urine§, reports a number of urinary analyses which support the view that the excretion of alkaline phosphates by the kidneys is habitually increased during mental work. This opinion has also received a certain degree of support from the more recent papers of Zülzer ‖ and Strübling¶; nevertheless it is impossible to

* Gamgee, p. 425 *et seq. op. cit. suprà.*

† Henry Bence Jones, "On the Variations in the Alkaline and Earthy Phosphates in Disease," Phil. Trans. for 1846, p. 449.

‡ Mosler, "Beiträge zur Kenntniss der Urinabsonderung," &c., Inaug. Diss., cited in Canstatt's Jahresbericht, 1853, Bd. i. S. 134.

§ H. Byasson, "Essai sur la relation qui existe à l'état physiologique entre l'activité cérébrale et la composition des urines," Paris, 1868.

‖ W. Zülzer, "Ueber das Verhältniss der Phosphorsäure zum Stickstoff im Urin," Virchow's Archiv, Bd. lxvi. 1876, S. 223.

¶ Strübling, "Ueber die Phosphorsäure im Urin," Archiv für exp. Path. und Pharm., Bd. vi. 1876–77, S. 266.

study the detailed observations upon which it is based without feeling how meagre and unsatisfactory the evidence relied upon really is. It is, at best, only sufficient to indicate the importance of further inquiry, and to suggest the necessity of avoiding certain obvious errors of method which complicate and obscure the results of the investigations hitherto made.

The opinion that mental effort is accompanied by an increase in the temperature of the brain was first propounded by Lombard in 1867. Using a delicate thermo-electric apparatus of his own contrivance, he observed during mental effort a rise of the surface temperature of the head, which sometimes amounted to as much as one-twentieth of a degree centigrade*. Subsequent and more elaborate investigations confirmed him in this conclusion, which has also been supported by observations made with thermo-piles by Schiff and Bert, as well as by the use of surface thermometers in the hands of Broca and L. C. Gray of Brooklyn†. Gray claimed to have observed a maximum rise of as much as two and a half degrees Fahrenheit. These physicians and some others have also investigated the relative temperature of the two sides of the head, of different regions on each side, the variations produced in certain regions by voluntary muscular movements, and those resulting from localized brain-diseases‡.

To attempt any discussion of these interesting studies and their conflicting results would lead me altogether beyond my prescribed limits. It is enough for my present purpose to

* J. S. Lombard, "Experiments on the Relation of Heat to Mental Work," The New York Medical Journal, vol. v. 1867, p. 199.

† J. S. Lombard, "Experimental Researches on the Temperature of the Head," Proc. of the Royal Society of London, vol. xxvii. 1878, p. 166; Idem, "The Regional Temperature of the Head," London, 1879; Idem, "Experimental Researches on the Temperature of the Head," London, 1881. Moritz Schiff, "Recherches sur l'échauffement des nerfs et les centres nerveux à la suite des irritations sensorielles et sensibles," Achives de Physiol. norm. et path. t. iii. 1870, p. 5 *et seq.* Bert, Communication to the Société de Biologie, read Jan. 18, 1879, in 'Gazette Hebdomadaire,' Jan. 24, 1879, p. 63. Broca, Communication to the French Association for the Advancement of the Sciences, at the Havre meeting of 1877, in Gaz. Hebd., Sept. 7, 1877, p. 577; also Gaz. Méd. de Paris, 1877, p. 457; Idem, in London Med. Record, Jan. 15, 1880. L. C. Gray, "Cerebral Thermometry," The New York Med. Journ. vol. xxviii. 1878, p. 31; also 'Chicago Journ. of Nervous and Mental Diseases,' vol. vi. 1879, p. 65.

‡ See, besides the papers cited in the last note, C. K. Mills, in the New York Med. Record, vol. xiv. 1878, p. 477, and vol. xvi. 1879, p. 130; Maragliano and Seppelli, "Studies on Cerebral Thermometry in the Insane," translated by J. Workman, 'The Alienist and Neurologist,' St. Louis, Jan. 1880, p. 44 *et seq.*; R. W. Amidon, "The Effect of willed Muscular Movements on the Temperature of the Head," 'Archives of Medicine,' April 1880, p. 117.

point out that the recent investigations of François Frank * would seem to indicate that the variations of temperature actually observed are chiefly due to changes in the cerebral circulation. Plunging suitable sounds, connected with a thermo-electric apparatus, into the brains of animals to different depths, Frank found that the deeper parts of the brain are always warmer than its superficial layers. The superficial layers are continually cooled by radiation, and their temperature is a degree, or more than a degree, centigrade lower than that of the deeper parts. Even these, however, are from 1° to 2° centigrade cooler than the blood in the thoracic aorta; and it will therefore readily be understood that a relaxation in the muscular coats of the cerebral vessels, permitting the more rapid circulation of a larger quantity of blood, would be promptly followed by an increase in the temperature of the superficial parts of the brain. None of the observers I have cited have reported a surface temperature of the head during mental effort that is too high to be accounted for in this way; and if, as I willingly concede is probable, there is really an increased heat-production in the brain itself, it is wholly masked by the more considerable change due to afflux of blood.

Now a consideration of the phenomena of blushing, and certain well-known sensations in the head, might lead us to expect that emotional and mental conditions would prove to be attended by increased activity in the circulation of the blood in the brain; yet many difficulties have hitherto been encountered in the attempt to demonstrate experimentally that this is true. Mosso of Turin supposed that he had succeeded in doing this with his plethysmograph †. The instrument is essentially a cylinder of water, into which the arm is introduced and so fastened in place by a caoutchouc membrane that the slightest increase or diminution in the volume of the arm will cause the rise or fall of the water, through a tube connected at one end with the interior of the cylinder and at the other with a suitable recording apparatus. The pen or pencil of this apparatus inscribes a curve that rises or falls with the fluid in the tube. Among the curious observations made with this instrument, Mosso reports that the mental operations and emotions of the persons he experimented on

* François Frank, Communication to the Société de Biologie, May 29, 1880, in Gaz. Hebd., June 11, 1880, p. 392.

† Angelo Mosso, " Sopra un nuovo metodo per scrivere i movimenti dei vasi sanguini nell' uomo," Atti della Reale Accademia delle Scienze di Torino, t. xi., Nov. 14, 1875. I have not obtained access to the original, but find an abstract in the Archives de Phys. norm. et path. 1876, p. 175. See also Barker, p. 12, *op. cit. suprà.*

were accompanied by a fall of the curve, which he regarded as proof that more blood goes to the brain and less to the arm during emotion, or mental action, than at other times. But the following year these observations were repeated with great care, and with an improved plethysmograph, by Basch, of Vienna*, who failed to verify them. Most of the phlegmatic Germans on whom he experimented did sums in their heads, and otherwise exerted their minds, without producing the slightest modification of the curve; and none of them appear to have been as emotional as Dr. Pagliani, of whom Mosso relates that, his arm being in the plethysmograph, when the revered Prof. Ludwig entered the room the curve fell as if he had received an electric shock. Basch has cautiously investigated the causes of the varying quantity of blood in the arm in these experiments, and has clearly shown how many general and local conditions concur in producing the result. Especially has he emphasized the effect of variations in the abdominal circulation, which appear to exercise a much more considerable influence upon the size of the arm than any changes that occur in the brain.

In subsequent works Mosso has stated that during mental effort, such, for example, as is required to multiply small numbers in the head, the radial pulse, as recorded by the sphygmograph, is shown to become somewhat more frequent, and the recording lever does not rise so high as at other times†. Thanhoffer, who has pointed out that in these observations the influence of respiration on the pulse was neglected, concluded, nevertheless, from his own sphygmographic observations, that after due allowance is made for this complicating influence, it must be conceded that cerebral activity does exercise a certain effect upon the pulse, and in the direction stated‡. Eugène Gley, in a recently published essay, claims to have obtained similar results, and states that at the same time the sphygmographic trace of the carotid artery shows a higher upstroke of the recording lever, and other indications of dilatation of the vessel§. While these observa-

* Basch, "Die volumetrische Bestimmung des Blutdrucks am Menschen," Stricker's Med. Jahrb. 1876, S. 431. See also Rollet, in Hermann's Handb. der Phys. Bd. iv. Th. 1 (Leipsic, 1880), S. 306.

† Mosso, "Die Diagnostic des Pulses in Bezug auf die localen Veränderungen desselben," Leipsic, 1879; also by the same, "Sulla circolazione del sangue nel cervello dell' uomo," Rome, 1880.

‡ Thanhoffer, "Der Einfluss der Gehirnthätigkeit auf den Puls," Pflüger's Archiv, Bd. xix. 1879, S. 254.

§ Eugène Gley, "Essai critique sur les conditions physiologiques de la pensée. État du pouls carotidien pendant le travail intellectuel," Archives de Phys. norm. et path., Sept.-Oct. 1881, p. 741.

tions are not sufficiently numerous, or free from objections, to be accepted without question as proof that an increased supply of blood to the brain invariably accompanies mental effort, they are certainly sufficient to encourage further labour in this interesting field.

But if the arguments in favour of the purely material nature of our mental operations that have been based upon the imperfect results of the three lines of investigation I have just referred to must be rejected as utterly fallacious, what shall we say of the logic that attempts to draw a similar conclusion from the results of those inquiries into the phenomena of personal equation which aim at determining the time that must be allowed for the mental operation involved? * Do we, then, indeed need the beautiful experiments of Hirsch and Donders† to prove that thought occupies time? Whence, indeed, do we derive our primitive conceptions of time save from our consciousness of the succession of thought? And how could even the shortest time be occupied by even an infinite number of thoughts if each thought did not occupy at least some time, however brief?

I have thus, gentlemen, attempted to show that we are logically compelled to invoke the existence of a vital principle in order to account for certain important groups of phenomena occurring in living beings which cannot possibly be explained by the chemical and physical forces of the universe. These phenomena form a series, at one end of which we find the mere irritability or sensibility of the humblest mass of living protoplasm; at the other the reasoning faculty of the human mind. From the one extreme of this series to the other I recognize the manifestations of the vital principle. I willingly confess that I know nothing of the ultimate nature of this principle, except that it must be very different from the chemical and physical forces whose operations I have learned to recognize in the organic as well as in the inorganic world; nevertheless I am compelled by my study of the phenomena to conclude that it exists. I know that Mr. Huxley, only last summer, declared in the International Medical Congress at London, that the doctrine of a vital principle is the "asylum ignorantiæ of physiologists"‡; but this ancient sarcasm has now been applied to so many things that it has long since lost whatever sting it may once have possessed, when it was fresh

* Barker, p. 11, *op. cit. suprà.*

† Hirsch, "Détermination télégraphique de la différence de longitude entre les observatoires de Genève et de Neuchâtel," Genève et Bâle, 1864. Donders, in Reichert and Du Bois-Reymond's Archiv, 1868, p. 657.

‡ T. H. Huxley, "The Connexion of the Biological Sciences with Medicine," 'The Popular Science Monthly,' October 1881, p. 800.

and new. And I also know that one of the chief characteristics of true science is the sharpness with which it enables us to discriminate between that which we have proven and really know and that which we have not proven and do not know. Better far is it, and a thousand times more in accord with the simple honesty of science, to acknowledge frankly the truth, that phenomena occur in living beings which the inorganic forces do not explain, than to mistake our wishes for discoveries, to convert conjectures into dogmas, or, worst of all, to transform an undemonstrated hypothesis into a superstitious, aggressive, and intolerant creed.

Nor will the soundness of the conclusions at which the present generation shall arrive as to this matter, be without its practical effect upon methods of biological research, and the consequent future progress of biological science. It is not a mere metaphysical subtlety, but a subject of practical importance, that I have asked you to consider to-night. For if the chemico-physical hypothesis of life be true, the only road of progress in biology lies through the chemical and physical laboratories. Now, I have already this evening more than once indicated how highly I esteem the class of biological work that has already been done in these laboratories, and I have endeavoured to show how large is the unexplored biological field that can be explored only in this manner. But in addition to all that we can ever hope to do in this direction—and I insist upon its importance—I insist also upon the importance of other lines of work: I insist upon the importance of the systematic study of the phenomena of growth and development, of generation and heredity, of sensibility and mind. All that can thus be learned we need to know, and not merely for its own sake. This knowledge is indispensable to the right interpretation of the succession of life upon the globe in the past, and the successful direction of the interference of the human will with the future succession of life upon the globe in accordance with human necessities. We shall make slow progress in this direction if we confine our efforts to the application of chemistry and physics to those phenomena of living beings that can be thus explained. The other phenomena, not thus explicable, must also be studied in detail, arranged into orderly groups, and made the basis of such inductions as our knowledge of them may warrant. It is only by pursuing this method that we can hope ultimately to acquire, with regard to the phenomena of living beings, that power to predict, which is the criterion of true science, and that power to control, which we so sorely need.

XXVIII.—*Note on Professor G. Seguenza's List of Tertiary Polyzoa from Reggio (Calabria)* *. By the Rev. THOMAS HINCKS, B.A., F.R.S.

WE are indebted to Professor G. Seguenza for a very able report on the Tertiary formations of Reggio, which includes a list of the Polyzoa found in the various beds of the district. Many species supposed to be new are described and illustrated by excellent figures. Amongst these are a number of forms that seem to me to have been raised to specific rank on very insufficient grounds; and as the maintenance of false species is clearly an injury to science, I venture to submit this portion of Prof. Seguenza's work to some critical revision.

Lepralia elegantissima, Seguenza (p. 83, pl. viii. fig. 11).

This is undoubtedly referable to *Cribrilina radiata*, Moll, form *innominata*, Couch. The species is a variable one; but Seguenza's Miocene form does not depart in any essential point from the type. It agrees very closely with the Pliocene *Lepralia innominata* of Manzoni (Sitz. d. K. Akad. d. Wiss. in Wien, lix. Bd. i. Abth. Jän.-Heft, 1869, pl. ii. fig. 13). The characters relied upon by Seguenza as distinctive (absence of avicularia, free development of oœcia, &c.) are quite insignificant. He remarks that *L. elegantissima* is most nearly allied to *L. radiata* and *L. figularis*, and more especially to the Floridan form of the latter †. This form, however, is not the true *figularis*, but merely a variety of *radiata* to which I have no doubt *elegantissima* also must be referred.

Lepralia radiato-foveolata, Seguenza (p. 129, pl. xii. fig. 20).

Identical with *Microporella violacea*, Johnston. There is perfect agreement with the latter species in all the essential characters, and even the superficial sculpture has a very exact parallel in the Crag form of *M. violacea*, which I have described in my 'History of British Marine Polyzoa' (p. 218, pl. xxx. fig. 4) ‡.

Cumulipora porosa, Seguenza (p. 130, pl. xii. fig. 21).

Not distinguishable from the well-known *Smittia trispinosa*,

* Contained in his valuable work entitled "Le formazioni terziarie nella provincia di Reggio (Calabria)." Memoria del Prof. G. Seguenza, 'Atti della R. Accademia dei Lincei,' 1879–80, serie terza, vol. vi. (physical science class), 1880.

† Smitt, 'Floridan Bryozoa,' pt. 2, pl. v. fig. 112.

‡ See also woodcut, fig. 12, on p. 219 of the same work.

Johnston. The oval and pointed avicularia, which are so characteristic of the species, are noted, and the pore, which is usually present on the front of the oœcium, is represented in the figure. The granulose condition of the surface is often met with in old specimens.

Lepralia radiato-porosa, Seguenza (p. 129, pl. xii. fig. 19).

A mere variety of *Schizoporella unicornis*, Johnston (including *L. ansata*, Johnston). The only characters noticed as distinctive are a larger number of radiating lines of pores than usual and a more prominent central umbo. Such slight superficial differences are without any special significance amongst the Polyzoa. The size of the umbo is one of the most variable characters.

Lepralia eximia, Seguenza (p. 203, pl. xiv. fig. 23).

There can be little doubt, I think, that this is identical with *Membraniporella nitida*, Johnston. So far as I know, the species has not previously been recorded as a fossil. Its range in time is now extended to the Pliocene period.

Lepralia Calabra, Seguenza (p. 201, pl. xv. fig. 6).

Undoubtedly a form of the protean *Microporella ciliata*, Pallas. In this species there is the greatest possible diversity *in the size of the cells*; the present seems to be a somewhat diminutive variety. Altogether this Pliocene form exhibits a very small amount of divergence from the type as compared with many of the known varieties; the specific facies is strongly marked in it. *M. ciliata* is as variable as it is cosmopolitan.

Lepralia mitrata, Seguenza (p. 203, pl. xv. fig. 8).

Referable to *Cribrilina radiata*, Moll, form *innominata*. The large size of the cells, the small number of prominent radiating ridges, the depth of the dividing furrows, giving a strongly crenate appearance to the margin, the papillose oœcium, all these are well known as occasional conditions amongst the many varieties of this variable form. They have none of them any specific value, as the study of any large series of specimens will abundantly show.

Lepralia coronata, Seguenza (p. 295, pl. xvii. fig. 6).

A variety of *Microporella Malusii*, Audouin, chiefly remarkable for the curiously furrowed surface of the oœcium, a peculiarity of the superficial calcification which has no special significance. The shape and basal areolation of the ovicell as well as all the characters of the cell in the Pliocene specimen are thoroughly typical.

Lepralia thiara, Seguenza (p. 370, pl. xvii. fig. 57).

= *Cribrilina punctata*, of very normal character. Pliocene and Quaternary.

Salicornaria mammillata, Seguenza (p. 294, pl. xvii. fig. 5).

Probably a species of *Myriozoum*; it is certainly not referable to *Salicornaria* (*Cellaria*).

Professor Seguenza's work is of such sterling character and will deservedly have so much weight with the student that it seems peculiarly desirable to prevent these spurious species, if possible, from sheltering themselves under its authority.

XXIX.—*On some* Stylasteridæ. By JOHN J. QUELCH.

To the Editors of the Annals and Magazine of Natural History.

GENTLEMEN,—In reply to the letter of Mr. Bryce Wright, I must first point out that one of the species of *Distichopora* to which I referred as having been omitted from his list was the *D. gracilis*, Dana, the only species of *Distichopora* that bears Dana's name. This was accidentally referred to in my paper as *D. fragilis*.

Mr. Wright states that he did not say that *D. nitida*, V., was of a whitish tint: I might reply, using his mode of expression, that I did not say that he *said* so; I said he *indicated* it; and to justify my statement I quote the following from Mr. Wright's original paper:—" the habitats of the living species being the Gulf-stream and in and about the West-India Islands and Florida, for *D. nitida*, Verrill, and *D. cervina*, *D. foliacea*, *D. sulcata*, *D. barbadiensis*, and *D. contorta* of Pourtales. Most of these species are of a whitish tint, with the exception of *D. foliacea*, which is a pale pink-orange, whereas those inhabiting the Pacific are much more vivid in their colours." I leave it to the judgment of any competent impartial person to decide whether I have misinterpreted Mr. Wright's words or not.

Believing, as Mr. Wright did, that *D. nitida*, V., was of a whitish tint, and that it was found in the West-Indian fauna, he could in all good faith describe Lady Brassey's very large and beautiful specimen as new; but as it happens that *D. nitida* has the same coloration as this specimen, varying from a bright red to light orange, agrees with it in its other essential features, and comes from very nearly the same locality in the Pacific, the specific name he has proposed cannot stand. The specimen is decidedly a typical example of Verrill's species.

Mr. Wright says, "*D. nitida* of Verrill, as judged by the Museum examples, it certainly is not." It is strange that Mr. Wright should have taken as his standard of comparison specimens doubtfully referable to Verrill's species—specimens which, as he himself remarks in his letter, have a query (?) appended to their names. His method of identification, which thus neglects the description itself of the species, is certainly peculiar.

I may point out again that the variation in the colours of different specimens of *D. nitida*, as described by Verrill, is remarkable; and the fine examples collected by Lady Brassey, as shown in the description and plates that have been given of them, are wanting in characters by which to separate them other than those of the very variable differences in the shades of the same colours—differences which are just such as one would expect to find in a series of specimens of *D. nitida*. On this account it seems to me that the forms described by Mr. Wright are neither specifically distinct from one another nor from Verrill's species.

Mr. Wright, in his letter, does not seem to me to be himself very sure of the specific distinctness of his second species from the *D. livida* of Tenison-Woods; and certainly his doubt seems justified by the close relationship which obtains between *D. livida* and *D. nitida*, as pointed out in my former remarks on Tenison-Woods' species.

In reply to Mr. Wright's note of exclamation, I may say that it really does not seem necessary to explain why, in appending a query to the names of specimens which, in the present state of knowledge, seem to be divergent and, perhaps, even doubtful forms of the species, I regard such a course as preferable to publishing them as new, or to labelling them definitely with the name of a species of which they cannot be regarded as typical examples, and from which, on further knowledge, they may have to be separated.

Lastly, I must say that I regret extremely to have to seem lacking in courtesy to the distinguished lady after whom one of the species was named by pointing out that the species cannot stand; but all true workers in natural history, who know the extreme difficulty of a complicated synonymy, will recognize the absolute necessity of preventing such complication in all cases where it is possible.

I am, Gentlemen,
Yours obediently,
JOHN J. QUELCH.

XXX.—*The Branched and Unbranched Forms of the Freshwater Sponges considered generally.* By H. J. CARTER, F.R.S. &c.

ACCORDING to my own actual experience as well as that of others, there are two distinct forms assumed by the freshwater sponges of England, viz. one stipitate, long-branched, and of a brown colour, and the other sessile, spreading, unbranched, and of a light fawn-colour when dry. The former has been called "*Spongilla lacustris*," and the latter "*Spongilla fluviatilis*;" but as they both grow in still as well as running water (that is, in lakes and docks as well as rivers) they were more or less confounded, until Lieberkühn definitively settled the differences between them, by pointing out that the former was characterized by the presence of a little, spined, curved acerate; and the latter by an amphidisk or birotulate spicule.

That the branched species was recognized as such by the earliest authority on *Spongilla*, viz. Plukenet, in 1696, is known by his having used the term "*ramosissima*" in his description ('Almagestum Botanicum,' p. 356); while Lamarck, in 1816 (An. sans Vertèbres, t. ii. p. 100), changed this to "*ramosa*," instancing at the same time Plukenet's representation "t. 112. fig. 3," and Esper's "t. 23 A" as illustrations of the species. Esper's "tab. 23" represents undoubtedly, under the name of "*Spongia lacustris*," the branched form of the freshwater sponge which we call "*Spongilla lacustris*" at the present day.

It is true that Lamouroux, in 1816 ('Hist. des Polypiers flexibles,' Engl. transl. 1824, p. 147), introduced the name "*Ephydatia*" (ἐφυδάτιος, of the water) for the freshwater sponges; but as Lamarck used that of "*Spongilla*" about the same time for the same organisms in his 'Hist. des An. sans Vertèbres,' without any allusion to Lamouroux's term, it may fairly be assumed that when the second volume of this great work was printed (viz. in the month of March 1816), Lamouroux's appellation had not been generally accepted, if, indeed, known or published.

Clear, however, as all this would appear to be, the confusion to which I have alluded extends down to 1842, when Johnston published his work on the 'British Sponges,' wherein he not only puts Esper's representation under his "*Spongilla fluviatilis*" (p. 159), but in his diagnosis of *Spongilla lacustris* never mentions any thing about branching; while the printed report of the "Joint Standing Committee on the Impurity of the Boston Water-supply" (Document 143—1881) contains an excellent illustration of the branched freshwater sponge of North America (viz. *Spongilla lacustrioides*, Potts), under which is the name "*Spongilla fluviatilis*." How far this may be owing to Johnston's mistake, which obtains in *his* illustration (pl. xviii.), as well as in his description, I am not able to say.

So much for the branched forms of the freshwater sponges of Europe and the United States. We have now to add *Uruguaya corallioides* from South America, and *Lubomirskia baicalensis* from Lake Baikal, in Central Asia, all the rest being, so far as I know, unbranched, sessile, spreading, plane, lobate, or rendered irregular on the surface by more or less projecting processes, but not all fawn-colour.

As regards *Spongilla lacustris*, Dr. W. Dybowski (Mém. de l'Acad. Imp. d. Sc. St. Pétersbourg, 1882, t. xxx. no. 10, pp. 6, 7) not only enumerates seventeen places in Russia where it has been found, but includes among them the "Pachabicha-See," at the S.W. extremity of Lake Baikal, from whence his brother brought back a branched ("baumförmige") specimen charged with statoblasts ("gemmulæ"); at the same time that he brought back the branched specimen of *Spongia baicalensis*, Pallas, which Dr. Dybowski has described, represented, and made the type of a new genus under the name of "*Lubomirskia*," calling the species "*L. baicalensis*" (*op. cit.* 1880, t. xxvii. p. 11, Taf. i. fig. 1), in which he found *no* statoblasts ("Gemmulæ habe ich niemals gefunden," p. 16), any more than in any of his sessile species of this genus and their varieties (*op. et loc. cit.*).

It is worthy of remark, however, that where the specimen of *Spongilla lacustris* was found, another species, which he has described, illustrated, and named "*Spongilla sibirica*" (*op. cit.* t. xxx. no. 10, p. 10), was obtained bearing statoblasts, seeing that it is identical with that obtained from the Schuylkill River, in Pennsylvania, by Prof. Leidy, and named by him "*Spongilla fragilis*;" as also by the late Mr. J. K. Lord at Lake Osogoos, in the Cascade Mountains of British Columbia, but hitherto in no other part of the world. That *Spongilla sibirica* is *Spongilla fragilis*, Leidy, is not only shown by the description, but confirmed by the characteristic, polygonal cell-structure among the statoblast spicules represented in the illustrations (Taf. iii. figs. 12 *a* and 12 *b*).

Then as regards *Uruguaya corallioides*, I have before stated that, under the most careful examination of several large specimens not a trace of a statoblast has as yet been found, so that (also as before stated) it becomes questionable whether it is ever propagated by statoblasts or not, seeing that the sexual as well as the statoblast means may take place in *Spongilla*, as pointed out by Lieberkühn in his *Spongilla erinaceus*, so far back as 1856 (Archiv f. Anat. Physiologie &c. Heft iv. p. 405, Taf. xv.).

Unfortunately, I have nothing but dried specimens of *Uruguaya corallioides* in my possession, so have been obliged to have recourse to an indirect method of examining the sarcodic parts under the microscope, which, however, has yielded much more than might have been expected; for by softening minute fragments of the interior of a branch from two different specimens, through placing them for a few hours in liquor potassæ, and then, after they have been washed, examining them under a microscope, the sarcode is found to be abundantly charged with spherical cells of a light brown colour, which are granuliferous and nucleated, together with others that are less round. These, when the fragments have been stained with magenta-dye (red ink), become much more deeply coloured than the other parts of the sarcode, and after having been washed in water and mounted in glycerine, afford a preparation which can be deliberately examined at any time.

The granulifero-nucleated cells in their sharply delineated spherical form are from 3- to 4-6000ths inch in diameter, which being much larger than the spongozoa ("Geisselzellen"), and much smaller than the ampullaceous sacs ("Geisselkammern"), both of which are also present for comparison, shows that the former are spermatic cells or young ova, or both mixed together; but here the analysis ends for want of a wet-preserved specimen or more matured ova, if there be any present.

It is not improbable that hereafter *Uruguaya corallioides* may be found to propagate itself by ova alone; but then this can only be determined by inference, since Lieberkühn, as just mentioned, has shown that the freshwater sponges may be propagated by ova or statoblasts.

Lastly, there is the inference that these granuliferous cells (for the granules are very large, spherical, and sharply defined) may be spermatic *alone*, and that *Uruguaya corallioides* may be nothing more than the male of a diœcious sponge; while it then becomes questionable whether a *male* form produces any statoblasts.

Miklucho-Maclay has long since given a series of illustrations (Mém. de l'Acad. Imp. de Sc. St. Pétersbourg, 1870, t. xv. no. 3, p. 1, Taf. 1), in which we find Pallas's *Spongia baicalensis* again represented (fig. 5); but here under the name of "*Veluspa polymorpha*, var. *baicalensis*" (p. 8), as derived from the marine form *Spongia oculata*, Pallas, of 1766, = *Chalina oculata*, Bk., of 1866, and the typical example of my order Rhaphidonemata; but although the least like of the branched freshwater sponges to *Chalina oculata* is *Spongilla lacustris*, it comes nearest in the form of its spicule, which is acerate, smooth, curved, fusiform, and sharp-pointed in both; while in *Lubomirskia baicalensis* it is spined, and in *Uruguaya corallioides* not only microspined but much curved, cylindrical, and round at the ends. On the other hand, in the general form of the sponges themselves it is almost impossible to be more like *Chalina oculata* than are *Uruguaya corallioides* and *Lubomirskia baicalensis*.

Still it is not what a sponge *may* have been, but what it *is*, that the student should chiefly concern himself about, and then it will be found inconvenient to put sponges bearing statoblasts with those which have none; hence my family Potamospongida is provisionally placed by itself at the end of my order Holorhaphidota, to which in texture *Spongilla* otherwise belongs. The typical form of the spicule in the Rhaphidonemata, just described, is identical with that of the Renierida, which is the first family of my Holorhaphidota; but the main support of the fibre in the former is the horny investment, while in the latter it is the axial core of spicules; thus the Rhaphidonemata are resilient and the Holorhaphidota may be crushed.

P.S.—Since the above was written, I have received (15th March) a packet from Dr. W. Dybowski (Niankow, near Novogrodek, in Minsk), in which he has kindly sent me copies respectively of his paper on the freshwater sponges of Russia, in the thirty-ninth vol. of the Imp. Acad. of Sc. above mentioned; of a notice of others sent to him by Prof. P. T. Stephanow, of the University of Kharkow, which he communicated to the Natural History Society of Dorpat in February 1883, among which is a new species from a little lake called

"Wielikœ," in the district of Lebeden, near Kharkow, for which he proposes the name of "*Dosilia Stephanowii*;" and, lastly, an illustrated copy of a description in Russian of this species &c., printed at Kharkow in 1884.

From the spicular illustrations of *Dosilia Stephanowii* in the latter (t. vii. fig. 1, *a–d*, which are neatly executed) it is evident that this species is closely allied to the mounted specimen of *Heteromeyenia repens*, Potts, which the latter kindly sent me, as the only exceptions are that the teeth of the disks in the birotules are not so claw-like or recurved, and the long spines of the flesh-spicules not inflated at the extremities, as in *H. repens*; but there are the same sparsely-spined skeletal spicules to be seen in both instances.

Thus another species of freshwater sponge analogous to *Meyenia plumosa* of Bombay and *Heteromeyenia repens* of Pennsylvania, if not to *M. Baileyi* also, has been found in Europe (*i. e.* in Southern Russia). As the skeletal spicule of *M. Baileyi* is not stated by Dr. Bowerbank to be spined, and the illustration is smooth (Proc. Zool. Soc. Nov. 1863, p. 13, pl. xxxviii. fig. 6, *a*), I cannot confidently affirm that in this respect also *it* accorded with that of *Dosilia Stephanowii*. In Mr. Potts's mounted specimen of *Heteromeyenia repens* (? *Meyenia Baileyi*) there are smooth as well as sparsely spined skeletal spicules present. Unfortunately there only exist the slides (three) of *M. Baileyi* in the British Museum for comparison; but this object has just (20th March, 1884) been kindly effected for me by Mr. S. O. Ridley, F.L.S., of the British Museum, who concludes his statement as follows, viz.: —"The specimens are nearly related, but, at the same time, it is not difficult to separate them under the microscope;" while I gather from the rest of his letter that the differences are hardly sufficient to constitute even a variety; hence it may be considered that Mr. Potts's and my conjectures respecting the identity of *Meyenia* (*Spongilla*, Bk.) *Baileyi* and *Heteromeyenia repens* are correct.

XXXI.—*Descriptions of five new Species of Heterocerous Lepidoptera from Yesso.* By Arthur G. Butler, F.L.S., F.Z.S., &c.

The following species were recently selected from a collection sent home by Mr. Henry Pryer:—

Lithosiidæ.

1. *Nola gigas*, sp. nov.

Belongs to the *N.-strigula* group, but is more nearly allied to *N. fumosa*; smoky grey, the primaries paler than the secondaries, but densely irrorated with grey scales, and glossy; the lines much less distinct than in *N. strigula*, the spots on the fringe less defined; the embossed spots on the discoidal area strongly marked; base of costal area blackish. Expanse of wings 34 millim.

Yesso.

Possibly allied to *N. gigantula* of Staudinger from Asia Minor; but the description of that species states that the lines across the primaries are more distinct than in *N. strigula*, the reverse being the case in the present species.

Acontiidæ.

2. *Chasmina atrata*, sp. nov.

Nearest to *C. nervosa*, of the same size, but the wings dark bronze-brown, with the base of primaries, excepting at costa, and the interno-basal area of secondaries snow-white, slightly opaline; fringe with the basal half grey and the external half white: body snow-white, antennæ dark brown. Wings below nearly as above, but the basal half of primaries irrorated with white in continuation of the white basal area of the upper surface; the basal half of costal border of secondaries white, and the centre of the wing irrorated with white scales: body below white; under surface of antennæ and proboscis castaneous. Expanse of wings 27 millim.

Yesso.

This species can be at once identified by its coloration, all the forms hitherto recorded being snow-white, *C. nervosa* only having the veins brownish.

Hypogrammidæ.

3. *Gerbatha pseudodyops*, sp. nov.

Nearly resembles the New-World *Dyops ocellata* in general coloration; agrees in the position and outline of its markings with *Xylophasia scolopacina*, with which I should have considered it congeneric but for its more slender body and smaller palpi; the general coloration of the primaries is slaty grey, spotted here and there with rust-red, the external area with cupreous reflections; the ordinary lines black, with white margins, better defined in some specimens than in others; ordinary discoidal spots edged with ash-grey or white and black; costal area irrorated with ash-grey scales; a pale irregularly undulated submarginal stripe, bounded internally near the costa and interrupted in the middle by sagittate black spots; a marginal series of depressed black spots; fringe brown, traversed by a darker stripe: secondaries fuliginous brown, with faint golden reflections; fringe whity brown, traversed by a blackish line: thorax brown, black-speckled; abdomen greyish brown, sericeous; anal tuft whity brown, with two black patches above. Primaries below greyish brown, glossed with cupreous, paler towards the external and internal borders; two parallel diffused irregular dusky discal stripes: secondaries whitish, with the apical half densely irrorated with rosy brown; a dark brown discocellular spot, an angulated discal stripe, and an abbreviated dash beyond the latter towards apex: body below whitish; legs brown-speckled; tarsi barred with black. Expanse of wings 36 millim.

♂ ♀. Yesso.

Boarmiidæ.

4. *Tephrosia excellens*, sp. nov.

Nearly allied to *T. crepuscularia*, but about one third larger in every respect, less yellow in tint; the male greyer, with less strongly ciliated antennæ. Expanse of wings, ♂ 51 millim., ♀ 58 millim.

Yesso.

Larentiidæ.

5. *Scotosia corrugata*, sp. nov.

Most like *S. undulata*; whity brown or sordid white; the primaries crossed by eleven to thirteen undulated parallel grey-brown stripes, two of which are darker, to indicate the central belt; a pale greyish submarginal band; basal half of secondaries crossed by four parallel grey-brown bands, followed by three parallel undulated stripes; a pale greyish submarginal band: markings below very indistinct, only indicated here and there. Expanse of wings, ♂ 32, ♀ 34 millim.

Yesso.

Although I have referred this species to *Scotosia*, this action is but tentative; like nearly all the large genera of moths, *Scotosia* will have to be subdivided, and the form of the wings (especially of the primaries *) in the male of this species will then probably entitle it to rank as a distinct genus.

XXXII. — *Coleoptera collected during the Expedition of H.M.S. 'Challenger.'* By Charles O. Waterhouse.

The present paper has reference only to the Coleoptera collected at Tristan d'Acunha, Ki Dulan, Aru Islands, and Tahiti.

TRISTAN D'ACUNHA.

Carmichael, in his "Description of Tristan da Cunha" (Tr. Linn. Soc. xii. pp. 497–8), says, "The only insects I observed are three small species of *Curculio*, four *Phalæna*, one *Hippobosca*, two of *Musca*, one of *Tipula*."

Probably the Curculionidæ referred to may be those described below as *Palæchthus* and *Pentarthrum*.

Lancetes varius, Fabr.

Hab. Inaccessible Island.

The eight specimens received are a trifle longer and narrower than the Chilian specimens; they have the anterior margin of the thorax pitchy, and the fuscous spot at the base extends beyond the middle of the thorax. The sterna and posterior coxæ are pale. All the Chilian specimens in the Museum collection have the sterna and coxæ blackish, and the fuscous marks on the thorax, when present at all, are very small. The Fabrician type from Patagonia has the thorax entirely yellow as well as the sterna and posterior coxæ. Babington's types, described as *Colymbetes nigrorematus*, from Port Famine and Port Desire, have scarcely any trace of the spots on the thorax, but have the sterna and coxæ black. Mr. Sharpe, in his monograph of the Dytiscidæ (Sci. Tr. R. Dublin Soc. ii. 1880–2, p. 604), under *Lancetes præmorsus* (the name he adopts for the species) gives Bolivia and Monte Video as additional localities.

Cercyon littorale, Gyll.

Hab. Inaccessible Island.

Two examples agreeing with European specimens.

* The male primaries are formed as in the genus *Chesias*.

Quedius fulgidus, Fabr.

Hab. Nightingale Island.

Numerous specimens agreeing perfectly with European examples. This species has occurred in very remote parts of the world.

PALÆCHTHUS, n. gen.

General characters of *Erirrhinus*, but with the third joint of the tarsi scarcely broader than the preceding, &c. Rostrum about the length of the thorax, rather stout, slightly curved, a little narrowed to the apex; the antennal scrobe commencing near the apex, extending to the eye, deep, bounded above by a ridge. Antennæ long, moderately slender; scape a little enlarged towards the apex; first joint of the funiculus about twice as long as broad; the second joint a little longer, the third to seventh subglobose; club ovate, the first joint smooth and shining. Eyes not large, not prominent, transversely ovate, a little sinuate anteriorly for the antennal scrobe. Thorax a little longer than broad, subparallel, a little narrowed at the base, rather more so in front, moderately flattened, with surface even; anterior margin slightly sinuate behind the eye; the anterior margin of the prosternum emarginate. Scutellum very small, elongate. Elytra at the base a little broader than the thorax, narrowed at the apex, arched posteriorly, the sides nearly perpendicularly; punctate-striate, the surface even, setose. Legs moderate. Anterior coxæ very prominent, contiguous; intermediate coxæ globular, prominent, separated by a narrow process; posterior coxæ transversely ovate. Femora moderately enlarged in the middle. Tibiæ bisinuate on the inner side; the outer apical angle obliquely rounded; the mucro distinct, especially to the anterior tibiæ. Tarsi moderately long and narrow, densely pilose below, the first, second, and third joints subequal in length; the third scarcely wider than the preceding, scarcely bilobed, with only a narrow incision at the apex visible from below; claws free. Metasternum very short, impressed posteriorly; parapleura extremely narrow. Abdomen with the divisions between the basal segments effaced (except close to the side), these segments concave; the intermediate segments very short, separated by very deep incisions.

The general form of the larger of the two species for which I propose this genus is somewhat that of *Erirrhinus maculatus*, but with a longer thorax, not narrowed at its base. The smaller species is rather more depressed.

Palæchthus glabratus, n. sp.

Elongatus, fusiformis, convexus, glaber, piceus; capite rostroque crebre subtiliter punctulatis; thorace latitudine paulo longiori, nitido, crebre evidenter punctato, basi medio impressa; elytris thorace paulo latioribus post medium gradatim arcuatim angustatis, nitidis, striatis, striis punctatis, interstitiis perparum convexis, subtiliter coriaceis, dimidio apicali fulvo-hirto; metasterno subtiliter (latera versus obsolete) punctulato, parapleuris angustissimis; pedibus punctatis, fulvo-pubescentibus, tibiis sat asperatis.

Long. (rostr. excl.) 12 millim., lat. $4\frac{1}{2}$ millim.

The rostrum has a fine, smooth, raised line, commencing at a round fovea which is between the eyes and extending to the apex. The eyes are distinctly narrowed below. The thorax is scarcely arcuate at the sides, slightly narrowed from near the base to the front, and also at the extreme base. The elytra have the shoulders obliquely rounded off with a slight impression above; the striæ are distinct posteriorly, but at the base are only represented by lines of fine punctures. The pubescence is stiff and dense at the apical declivity, particularly on the suture, and forms a slight tuft at the apex of the fourth stria.

Hab. Nightingale Island (Oct. 17, 1873).

Three examples. Probably the pubescence would be found in fresh examples to exist, to a small extent, on the thorax and base of the elytra.

Palæchthus cossonoides, n. sp.

Elongatus, subparallelus, depressiusculus, pallide piceus, parce flavo-setosus; thorace fere parallelo, ad apicem ipsum angustato, crebre evidenter punctato, depresso; elytris ad apicem arcuatim angustatis, leviter striato-punctatis, interstitiis parum nitidis, punctis parvis setigeris sat discretis seriatim dispositis.

Long. (rostr. excl.) $7\frac{1}{2}$ millim., lat. $2\frac{1}{4}$ millim.

Much more depressed than the foregoing species, and more parallel in outline. The rostrum is relatively a little shorter (a little shorter than the thorax), only very slightly arched, the punctuation obscure and confused, the fovea between the eyes almost wanting. The thorax is more parallel, only narrowed just before the apex and at the extreme base; with no dorsal impression. The elytra are more depressed, and consequently the posterior declivity is more gradual; the striæ are represented by lines of fine (generally elongate) punctures; the pubescence is more sparse and more equally distributed.

Hab. Nightingale Island. A single example.

Pentarthrum Carmichaeli, n. sp.

Statura fere *P. Huttoni*, minus nitidum, pallide piceum, aureo-pubescens; rostro paulo longiori, thorace lateribus postice magis rotundatis, creberrime punctato; elytris fortiter striatis, striis confertim evidenter punctatis, interstitiis convexis, seriatim punctatis.
Long. (rostr. excl.) $3\frac{1}{2}$ millim., lat. 1 millim.

The rostrum a little longer than in *P. Huttoni*, nearly parallel, rather dull, finely and rather closely punctured at the base, the punctuation beyond the middle excessively fine and longitudinally confluent. Eyes moderately prominent. Antennæ rather short and stout, beset with long hairs; funiculus 5-jointed, the first joint a trifle longer than broad, narrowed at the base, the second as long as the first; the third, fourth, and fifth shorter, subequal; the club elongate-ovate, pilose. Thorax moderately flattened, the surface finely coriaceous, very thickly and moderately strongly punctured, broadest at one third from the base, narrowed in front and at the base, the sides distinctly rounded. Scutellum small and rounded. Elytra at the base not quite so broad as the broadest part of the thorax, somewhat flattened, parallel, arcuately narrowed at the apex, strongly striated, the striæ closely and moderately strongly punctured, the punctures rather transverse; the interstices convex, each with a single irregular line of small punctures; all the punctures bear golden hairs, which have a slight greenish tint in some lights. Tarsi short and stout; the third joint broad and excavated nearly as in *P. Huttoni*, not bilobed.

Hab. Inaccessible Island. Several examples.

KI DULAN.

Leptochirus samoensis, Blanch.

A single example, which appears to be referable to this species.

Aceraius Germari, Kaup.

Many examples. The specimens in the Museum collection are from Ki Island and Aru Island.

Pelops * *gularis*, n. sp.

Niger, nitidissimus; elytris punctato-striatis; interstitiis parum convexis; gula parum nitida; processu prosternali postice sat

* Kaup, Berlin. ent. Zeit. xv. (Mon. Passalidæ), p. 37.

convexo, opaco; metasterni lateribus late confertim ruguloso-punctatis, basi utrinque punctis nonnullis impressa.
Long. 21 lin.

This species is very close to *P. Salamonis*, Kaup (Berl. ent. Zeit. xv. p. 39), but a little smaller. Labrum beset with reddish hairs, sparingly and strongly punctured, deeply emarginate, the left lobe a little the longer. Middle of the epistoma considerably produced forwards, with a deep quadrangular emargination. Thorax moderately convex, smooth, with scarcely any trace of the middle line; the lateral impression is oblique and not very deep, smooth; at the anterior angles there are a few punctures. Elytra with the striæ rather deeply impressed; the punctures in the sutural stria are scarcely visible, but in each stria the punctures are more distinct as the sides are approached; the punctures in the lateral striæ are deep, *very* close together, and transverse; in *P. Salamonis* these punctures are scarcely transverse, and are more distinctly separated from each other. The middle portion of the gula is smooth, semicircular in outline, gently convex, slightly opaque on each side, not impressed on each side of the base, as it is in *P. Salamonis*. The prosternal process is somewhat dull posteriorly, subparallel, moderately convex, and not flattened at the apex, as it is in *P. Salamonis.* The sides of the metasternum are densely and finely rugulose and opaque, and on each side of the base there are some rather strong punctures as in *P. Salamonis*.

A single example.

Pœcilopharis truncatipennis, Ritsema.

A single specimen. This species is described (Notes Leyden Mus. iii. 1881, p. 1) from a male from the Aru Islands.

The following more or less widely distributed species were also met with:—*Eupholus Linnei*, Th. (1); *Sipalus granulatus*, Fabr. (2); *Sphenophorus obscurus*, Boisd. (1); *Chlorophanus annularis*, Fabr. (1); *Aulacophora rubrozonata*, Boisd. (1). Also a single specimen of the genus *Praonetha* which I am unable to determine.

ARU ISLANDS (*Wokam, Dobbo, and Wanumbai*).

The following is a list of the species met with in these islands:—

Therates labiatus, Fabr.; *Tricondyla aptera*, Oliv.; *Rhopea aruensis*, Lansb.; *Anomala æneiventris*, Fairm.; *Cautires* *amabilis*, n. sp.; *Metriorrhynchus cinctus*, Waterh.; *Trichalus flavicans*, Waterh.; *Sphærarthrum* (n. gen.) *præustum*, Guérin; *Lagria pulchella*, Guérin; *Eupholus Linnei*, Th.; *Celeuthes cinerascens*, Blanch.; *Isomerinthus tessellatus*, Bl.; *Alcides albolituratus*, Bl.; *Paipalesomus dealbatus*, Boisd.; *Acalles pallens*, Bl.; *Miolispa suturalis*, Pascoe; *Ithystenus frontalis*, Pascoe; *Tmesisternus marmoratus*, Guérin; *Rhiparida nigroænea*, Baly; *Stethotes lateralis*, Baly; *Æsernia magnifica*, Baly; *Galleruca*, sp.; *Aspidomorpha punctum*, Fabr.

The following is a description of the new species of Lycidæ mentioned above as *Cautires amabilis*:—

Cautires amabilis, n. sp.

Niger; thorace elytrisque ochraceis, his apice nigris. ♂. Long. 6 lin., lat. $1\frac{3}{4}$ lin.

Eyes large and prominent. Antennæ moderately long; the first joint rather large, the second small and partially hidden by the first, the third about $\frac{3}{4}$ millimetre long, with a rather narrow branch 3 millimetres long arising from the extreme *base* of the joint, the branch pilose; the fourth to eleventh joints each a trifle longer than the preceding, the branch proportionally longer, the apical joint long, flat, a little narrowed at the apex. Thorax rather broad, quadrangular, clothed with yellowish-red silky pile, the middle of the anterior margin somewhat produced, reflexed, and thickened; the sides reflexed; the discoidal areolet moderately broad in front of the middle, extending to the basal margin, united to the anterior incrassate margin by a short costa; there is a slight costa on each side, arising from the median areolet rather in front of the middle, and extended to the side of the thorax; the two anterior median areolets are but faintly indicated. Scutellum oblong, emarginate at the apex. Elytra long, parallel, each with nine costæ, the second, fourth, and sixth distinctly stronger than the others; the intervals with lines of strong, generally slightly transverse punctures; the apical fifth blackish.

This species has much the appearance of some species of *Metriorrhynchus* from Australia (e. g. *M. abdominalis*, W.).

The following is the description of the new genus of Telephoridæ mentioned above:—

SPHÆRARTHRUM, n. gen.

I propose this name for a small Telephorid which appears to be common in the islands visited by Mr. Wallace. It is parallel in form, with the segments shining, and in appearance somewhat resembles *Telephorus ruficollis*, but with excessively fine punctuation on the elytra. The male has the basal joint of the antennæ large, inflated, somewhat globular, and shining; the second joint is rather short, linear; the third is nearly twice as long as the second; the following joints longer and more slender, slightly diminishing in thickness to the apex. The female has the antennæ similarly constructed, except that the basal joint is normal. The anterior claw to all the tarsi is bifid at the apex in the male, simple in the female.

I think this genus should be placed near *Anisotelus*, with which it agrees in having a large basal joint to the antennæ (although of a different form), but from which it differs in form and in not having the antennæ enlarged at the apex, and widely separated at the base. In the Munich Catalogue *Anisotelus*, Hope * (Royle's 'Himalaya,' p. 55), is placed as a synonym of *Tylocerus*, a genus founded on a West-Indian insect. I think the two genera should be kept distinct, the males having the anterior claw to all the tarsi bifid in *Anisotelus*, and only the anterior claw of the front tarsi in *Tylocerus*.

Sphærarthrum præustum.

I believe that it is the female of the species in question which Guérin has described (Voy. Coquille, p. 75) under the name of *Telephorus præustus*, from New Guinea. There are numerous specimens in the British-Museum collection from Dorey, Aru Islands, Batchian, Amboyna, and Mysol.

The antennæ are generally blackish, with the basal joint either black, reddish, or yellow. The head (except in one of the specimens from Batchian) is yellow. The thorax is always yellow. The elytra are yellow, with a little black at the apex, half black, or nearly all black, or blackish with the suture and margin yellow. The legs are yellow, with the tarsi dusky, except the female specimen from Batchian with the black head; this has the legs black. The male example from Batchian has the head yellow (with a little dusky mark on the forehead), the elytra broadly margined at the suture and sides with yellow, and the legs yellow.

A single female example.

* It may be well to point out that the following species mentioned in a few words by Hope in Gray's Zool. Miscell. p. 26, are omitted (perhaps purposely) from the Munich Catalogue:—*Telephorus rubricollis, cyanurus, trimaculatus, unipunctatus, purpurascens, assimilis*; *Anisotelus lividus, bispilotus.*

Miolispa suturalis, Pascoe.

The specimen brought is entirely black, except a yellow stripe on each elytron. It does not, however, appear to differ in any other respect from the usual red examples with black head.

TAHITI (*Lake Waihiria*).

Anchomenus anachoreta, *eremita*, and *monticola*, Fairm.

The three species brought by the Expedition from Lake Waihiria appear to correspond with the three described by M. Fairmaire (Rev. Zool. 1849, p. 283) from the same locality. If this be the case, however, his descriptions are not strictly accurate.

He states that *A. anachoreta* and *A. eremita* have the striæ of the elytra impunctate. This can only apply to the dorsal striæ, as the lateral ones are distinctly punctured, and even the dorsal striæ are seen to have punctures if the insect is viewed obliquely. The punctures are more obscure in *A. eremita* than in *A. anachoreta*. The sculpture of the interstices of the striæ of the elytra is so excessively fine and delicate in *A. eremita* that it can only be seen with a strong magnifying power, and the interstices consequently appear highly polished. In *A. anachoreta* the sculpture is still very fine, but is seen much more easily, whilst in *A. monticola* it is visible with a weak magnifying-glass and renders the surface slightly opaque.

It appears to me from description that *Dyscolus castaneus*, Bohem. ('Eugenies Resa,' p. 16) is the same as *A. monticola*.

These species are correctly placed under the genus *Colpodes* in the Munich Catalogue.

Colymbetes pacificus, Boisd.

Two examples.

Sphenophorus obscurus, Boisd.

Two examples.

British Museum, South Kensington,
March 15, 1884.

XXXIII.—*On the Classificatory Value of Growth and Budding in the* Madreporidæ, *and on a new Genus illustrating this point.* By STUART O. RIDLEY, M.A., F.L.S., &c., Assistant in the British Museum (Natural History).

[Plate XI.]

THE manner in which growth is effected in the corallum has long been considered a character of very great importance for the systematic division of the Madreporaria.

Thus MM. Milne-Edwards and Haime (Hist. Nat. Corall.) appeal constantly to the characters gemmiparity and fissiparity, and the various modifications of gemmiparity, in the formation of their genera, and (*e. g.* Astrangiaceæ, Oculinidæ) sometimes in the distinction of larger groups; they point out at the same time that gemmiparity may occur in a group (Turbinoliidæ) whose members are not normally compound.

In the genus *Madrepora* the characteristic form of increase has been held by the highest authorities to be that of lateral extracalicinal gemmation from a primary zooid. Thus Ehrenberg (Cor. roth. Meer. p. 108) defines that section of his family Madreporina which he calls *Heteropora*, but which is now termed *Madrepora*, as follows:—"Stella ramulorum qualibet solitaria, gemmipara, sæpe maiore (gubernatrice), reliquis raro gemmiparis, minoribus (frutices erectos, ramosissimos, prostratosve formant)."

Dana's generic diagnosis of *Madrepora* (U.S. Expl. Exp. Zooph. p. 431) is:—"Patrio-ramose; arborescent, cæspitose, or, through coalescence, reticulate or foliaceous. Coralla with the branches terete (very rarely compressed); calicles regular." He says further, "The genus *Madrepora* includes species which bud from a parent-polyp, with which each branch terminates. . . . But two or three species are known in which the apical polyp cannot be distinguished; and these form a connecting-link between this genus and the following" (the following genus is *Manopora*, Dana, = *Montipora*, De Blainville). The three species mentioned by Dana as not having an apical polyp are *M. cuneata*, *labrosa*, *securis*.

Milne-Edwards and Haime (Hist. Nat. des Coralliaires, p. 132) define *Madrepora* thus:—"Polypiérites réunis en masses ramifiées, fasciculées ou lobées. Calices saillants, au moins dans le jeune âge, à ouverture petite ou médiocre et à bords assez épais. Cloisons non débordantes. Columelle nulle;" and continue, pointing out that budding is usually circular and that "le polypiérite souche de chaque pousse est presque toujours plus développé que ceux dont il est entouré et constitue à l'extrémité de chaque branche ou ramuscule, un calice dit apical, qui est plus grand et plus proéminent que les calices latéraux."

Verrill ("Review of the Corals and Polypes of the West Coast of America," Trans. Connecticut Acad. i. (1869) p. 501) says of *Madrepora* and *Montipora*, "The resemblance between certain species of these two genera, both in appearance and structure, is very close, the chief difference being that in *Madrepora* there is usually a terminal or leading polyp at the end of each branch, which is not the case in *Montipora*." Klunzinger (Korallenthiere des rothen Meeres, ii. p. 2) commences his account of *Madrepora* by stating that "the colony bears branches which are usually more or less round, and the terminal calicle of which is always distinguished by size or shape from the numerous lateral calicles which lie as lateral buds around the median calicle." Studer (Monatsbericht Akad. wiss. Berlin, 1878, p. 535) does not define *Madrepora*; but at the end of his account of those species of the genus collected by the 'Gazelle' establishes a new subgenus, which he calls *Isopora*, and defines as "Cormus foliar or lobate, the calicles projecting equally, distributed evenly over the whole colony, no specially differentiated apical calicle," placing under it *Madrepora securis* and *labrosa* of Dana. [In view of the unwieldiness of the large genus *Madrepora*, it is perhaps desirable that it should be thus subdivided for working purposes in this way into minor groups or subgenera, and perhaps *M. elegans* might advantageously be similarly set aside from the rest of the genus, as suggested by Milne-Edwards and Haime (*l. c.*).] Subsequently (see below, *ad fin.*) Studer suggests fission or marginal gemmation as the mode of growth in *Madrepora*.

Now it seems to me that while these various accounts of the distinctive characters of *Madrepora* as opposed to *Montipora* lay sufficient weight on the external *facts* of this distinction, they do not, as a rule, bring forward the underlying law of which these facts (*i. e.* the terminality or non-terminality of the distal calicles) are merely an expression, viz. the character of the budding, which is essentially and fundamentally diverse in the two cases.

To how great an extent this essential difference has been overlooked seems to be strikingly shown by Dana's remark above quoted, to the effect that the species of *Madrepora* without an apical calicle "form the connecting-link between this genus" (*Madrepora*) "and the following" (*Montipora*). This assertion does not even find support in the evidence he adduces, viz. the growth of these species in erect or incrusting plates, and the absence of an apical polype, for the simple fact is, that, though in the species referred to there is no *one* apical polype, there are instead *several*. I have examined two of these species, *labrosa* and *cuneata*, and find that the ends of the branches are well covered by large calicles, at the sides (and in *cuneata*, at any rate, *from* the sides) of which originate young calicles. The fact that there is no *one* apical calicle appears to be due to the fact that on the broad ends of the lobes all calicles are equally circumstanced, whereas in the pointed-ended *Madreporæ* the terminal calicles stand alone in position and circumstances.

In point of fact the most essential distinction between *Madrepora* and *Montipora* is thus overlooked by Dana. In *Madrepora* (as may be seen at once by examining the ends of branches of any species except *labrosa*, *securis*, *cuneata*) one or more calicles take the lead in the growth, and others originate *below* them, constituting a *centrifugal* method of budding; in *Montipora* an undifferentiated apex of cœnenchyma takes the lead in the growth (as may be well seen in both the widely different species *M. foliosa*, Pallas, and *digitata*, Dana), and new calices originate in this cœnenchyma *above* the already formed calicles; in other words, the budding is *centripetal*. This distinction lies so deeply rooted in the structure and physiology of these corals that it is difficult to see how a directly "connecting-link" between the two types can be found. I should rather expect to find the connecting-point far back in some common form in remote geological time.

The distinction is the same as that denoted in flowering plants by the terms "determinate" and "indeterminate inflorescence." In a determinate inflorescence growth is centrifugal, the first flower being formed at the apex; in an indeterminate inflorescence the first flowers are formed at the sides and they successively *approach* the centre or apex of the spike. The distinction appears to me to furnish a good character by which to divide the Madreporinæ from the Montiporinæ (sufficiently closely allied to each other and removed from the Poritidæ, as it seems to me, by the possession of a spongy cœnenchyma, of a well-developed and deep calicle, devoid of columella and pali); hence I would classify Madreporidæ as follows:—

Subfam. 1. *Madreporinæ*.—Gemmation centrifugal, from the sides of terminal calicles.

Subfam. 2. *Montiporinæ*.—Gemmation centripetal, from a terminal cœnenchymal mass.

A new genus, which I describe below under the name *Ana-*

cropora, referable, from the character of its budding, to the subfamily Montiporinæ, fully bears out these views as to the nature and importance of the mode of gemmation occurring in that subfamily.

Anacropora *, n. gen.

Madreporidæ of ramose habit. Axis and apex of branches formed by a spongy cœnenchyma. New calicles formed centripetally, *i. e.* from the base towards the apex; no calicle of any kind at the apex. Calicles equally distributed all round stem and branches, with a tendency to an arrangement in longitudinal series. Septal system well developed, comprising two cycles of six septa each, two (approximately upper and lower) primaries being larger than the four lateral primaries.

Obs.—*Anacropora* is based on the new species *A. Forbesi*, described below, and on some forms which occur in the 'Challenger' collection of reef-corals, to be hereafter described by Mr. J. J. Quelch, of the Natural-History Museum; I have had the advantage of Prof. Duncan's and Mr. Quelch's opinions on this important form, opinions which have been freely and kindly given. The general growth and other characters given above are essentially the same in all the species. In all the growth is low, the branches tending to form inosculations between each other; the stem and branches are cylindrical, and no distinct tubular calicles are formed.

From *Madrepora* this genus differs markedly in the centripetal production of the calicles, by which the youngest calicles are always the uppermost. From the subgenus *Isopora*, Studer (see above), it differs in the same point, as well as in its slender dendroid growth; but the first distinction is not so marked at first sight, since the peculiar growth of *Isopora* almost necessitates the absence of a *distinct* apical calicle, but (as stated above) the mode of gemmation is centrifugal in *Isopora*, as in *Madrepora* s. str. Other points distinguishing *Anacropora* from most species of *Madrepora* are the formation of the axis of the branches by a spongy cœnenchyma, whereas in many (if not all) *Madreporæ* this, in accordance with the centrifugal habit of budding, is occupied to a greater or less distance from the ends of the branches by the downward prolongations of the septa and the interseptal spaces of the apical calicle. The rudimentary condition of the external part of the calicle distinguishes *Anacropora*; for although it is

* From ἀν, privative particle, ἄκρος, summit, πόρος, passage or pore; in allusion to the absence of pores from the ends of the branches.

commonly found (I refer to the sunk calicles occurring in so many species between the prolonged tubular or nariform ones) in *some*, it is never, so far as my knowledge extends, found in *all* the calicles in any *Madrepora*.

Although in its general appearance it differs remarkably from even the branched species of *Montipora*, yet the structural differences which separate *Anacropora* from this genus are very far less distinctive than those which separate it from *Madrepora*. In the first place, in spite of its external resemblance to *Madrepora*, it has the same system of calicular budding (viz. centripetal, from the distal cœnenchyma) which we find well developed in the ramose *Montipora*; the trabecular structure and the two-cycled arrangement of the septa is the same in both genera. On the other hand, whereas in *Anacropora* there is always an undifferentiated cœnenchymal apex, devoid of calicles, to the branches, in *Montipora* this apex appears always to bear at least one calicle on its surface. In *Anacropora* the calicles are always rather distant and tend to form lines, and are slightly raised above the surface, forming low hill-like eminences, whereas in the ramose *Montiporæ* (e. g. *digitata*, Dana, *divaricata* and *superficialis*, Brüggeman), which on the whole most closely approach *Anacropora*, the calicles open flush with the surface, are crowded indiscriminately, and no linear arrangement is apparent. In *Montipora foliosa*, it is true, the calicles, especially on the posterior aspect of the corallum, are elevated in a similar manner; but the foliate growth and the monticular *inter*-calicular eminences of the upper surface seem to remove this species far from the ramose *Montiporæ*. It seems to me not improbable that, for the reasons I have indicated, these ramose forms may have to be separated from the foliate and massive species of *Montipora*.

The relations of *Anacropora* may be thus shortly stated:—*Anacropora* has the general growth of *Madrepora*, but the manner of budding of *Montipora*.

The following is a description of the single species referable to this genus which I am able to describe; owing to the interest attaching to the type, I have allowed myself to give its characters at full length:—

Anacropora Forbesi, n. sp. (Pl. XI.)

Corallum branching frequently, dichotomously, occasionally subtrichotomously; branches given off in succession in a subspiral manner, the planes of successive bifurcations varying from about 30° to 100° with regard to each other; angle between branches composing bifurcation 80° to 100°. Stem and branches slightly curved, the apical branches more strongly so, cylindrical, except the terminal branches, which tend to curve outwards and taper gradually to points; diameter, main axes 6–7 millim., intermediate and terminal branches about 4 millim., greatest length between bifurcations of main branches about 30 millim., terminal twigs 25 millim. long. Calicles arranged more or less definitely, for the most part in series which follow approximately the longitudinal axis of the stem and branches, the calicles of one series alternating with those of the adjacent series; series about 2 millim. apart, calicles about 2 to 2·5 millim. apart in the series. Calicles forming, everywhere but on the tips of the branches, low rounded elevations, by the gradual rising of the surface towards their inferior margins to a height of ·25 to ·7 millim., and occasionally by the similar but very slight elevation of their superior margins. Calicles orbicular, looking upwards; orifice of adult calicles ·5 to ·7 millim. in diameter; on the tips of the branches they open on the level of the surface of the corallum, are more or less imperfectly defined from the surrounding loose cœnenchyma, and measure about ·25 to ·4 millim. in diameter. Septa trabecular, consisting of vertical series of horizontal pointed projections from the wall of the calicle, beginning just below its margin, distinct. Primaries about ·25 millim. in length in full-grown calicles, comprising two main, opposite ones, variously placed (*i. e.* from parallel to the long axis to at an angle of 45° with the same), which converge towards the bottom of the calicle, where they meet and form a vertical plate; the other primaries are slightly smaller and do not meet below. Secondaries varying from about half the diameter of primaries to mere points on the side of the calicle; the secondary septum between the two lateral primaries is sometimes wanting.

Corallum slightly vermiculate, always covered by minute points at surface (at apex looser, very porous); the outer one-quarter of diameter (except at apex, see fig. 5), formed of a denser tissue, in which the calcareous trabeculæ exceed in diameter the spaces between them; the central one-half of the diameter (viz. usually about 2 millim.), consisting of a loose tissue, in which the calcareous bars are only about half the diameter of the intervening spaces; the meshes of this tissue (as seen in transverse section of a branch) elongate towards margin, smaller and relatively shorter at centre. Apices of branches, to a distance of from 2–8 millim. from the ends (see fig. 5), formed of the looser axial cœnenchyma, and carrying more or less rudimentary calicles, which are at least 1 millim. from all other calicles in the same longitudinal series.

Hab. Keeling Islands, Indian Ocean; deeper water inside reef.

Represented by a single colony (fig. 1) and a detached branch, which has lived independently after its fracture from the parent specimen. They were collected and presented to the British Museum by Mr. H. O. Forbes, F.Z.S. &c., who has already (Proc. Roy. Geogr. Soc., Dec. 1879) described these islands, and with whose name I have much pleasure in associating this new type. The chief colony measures 83 millim. ($3\frac{1}{3}$ inches) in height, 100 millim. (4 inches) in greatest breadth, and 55 millim. ($2\frac{1}{4}$ inches) from front to back; the detached branch, which bifurcates three times, was about 60 millim. long when alive. Parts of the corallum, owing either to an evanescent pigment or to traces of animal matter, have a most delicate pink tint.

Some interesting points are brought out by the detached branch; this occurs unrooted, but obviously had been broken off from the colony while yet alive (see fig. 4) and lived subsequently free. As commonly happens in such cases, the fractured surface has healed over; but in this case the new material is not a continuation of the *superficial* cœnenchyma of the adjacent side over the stump, but the prolongation outwards of the loose central cœnenchyma which has developed on itself five or six young calicles. Here also the law of centripetal gemmation asserts itself, these calicles occurring on the sides of a central cone of loose cœnenchyma, of which the apex, 1 millim. long, is undifferentiated and bears no calicles. The same law is followed in the process of repair exhibited by a broken stump of a branch on the larger specimen. The wide angle of bifurcation of the branches causes the colony to assume a low decumbent form, and bringing, as it does, neighbouring branches into juxtaposition, gives rise to anastomoses; the branching in various planes gives it a broad top.

Bilateral Symmetry in the Madreporidæ.—In *Madrepora elegans* we have a decided bilaterality in the arrangement of the calicles on the corallum, a circumstance which has induced MM. Milne-Edwards and Haime to entertain the idea that this form might be generically distinct from *Madrepora*. No other Madreporidæ exhibit this, so far as I am aware; bilaterality in the arrangement of the parts of the calicle is, however, a prominent feature of a number of *Madreporæ*, taking the form of a superior development of the upper and lower (distal and proximal) primary septa, sometimes carried to the extent of their union in the middle line at no great distance below their upper margins. In *Montipora* also (at any rate, in *digitata*, Dana) the primaries are thus distinguished; but here they are not always strictly upper and lower in relation to the long axis of the branches. This form of calicular bilaterality is well marked also in *Anacropora*, although I have not observed it to extend to the union near the summit of the calicle of the two leading septa; in this genus also these two septa are sometimes placed diagonally with relation to the axes of the branch (see fig. 2). Klunzinger (Kor. roth. Meer. ii. p. 2) states that in *Madrepora* one of these two (which he calls "Hauptsepta") has its corresponding tentacle longer than the other eleven tentacles.

In *Seriatopora* these two septa are represented *in position* by the long plate which extends from the proximal to the distal wall of the calicle, *i. e.* in the direction of its (here) longer axis; but the fact that, as Prof. Moseley has shown (Quart. Journ. Microsc. Sci. n. s. xxii. p. 392), six primary septa are present without counting this, seems to favour Milne-Edwards and Haime's view, that this plate is columellar, not septal, in origin—in which case *Seriatopora* would differ from the Madreporidæ in having its primary septa wholly distributed to the right and left of a dorso-ventral line.

Budding or Fission in Madrepora?—Prof. Studer, in his paper on Budding and Fission in the Madreporaria (Mitth. naturf. Ges. Bern, 1880, p. 3), surmises (p. 14) from appearances that in the Madreporidæ (he evidently refers only to *Madrepora*, as *Montipora* has no apical calicle) the new calicles are really formed by fission or lateral gemmation from the margin of the apical calicle, which he thinks sends out curved bulges from its margin. All the evidence I have gathered myself from *Madrepora* is rather in favour of the old view that the buds are formed from the sides of the wall of the apical calicle in this genus.

EXPLANATION OF PLATE XI.

Fig. 1. *Anacropora Forbesi*, the chief specimen, seen somewhat from above. Natural size.

Fig. 2. Ditto, part of a main branch of the same specimen, showing characters of adult calicles and of the exterior of the cœnenchyma. × 6 diameters.

(Note that one calicle has the main primary septa dorsoventral, the other diagonal in position.)

Fig. 3. Ditto, vertical section of main branch of the same specimen, showing:—*a*, axial; *b*, superficial cœnenchyma; and *c*, longitudinal section of a calicle. × 6 diameters.

Fig. 4. Ditto, basal end of detached branch, showing the renovation of the stump by the emergence of the loose axial cœnenchyma and the formation in this cœnenchyma of young calicles. × 3 diameters.

Fig. 5. Ditto, apex of branch of chief specimen, showing the loose texture of the cœnenchyma at this point and the formation (as in fig. 4) of young calicles from this loose cœnenchyma. The view selected shows an unusually regular longitudinal series of young calicles. × 3 diameters.

XXXIV.—*Preliminary Notice of new Genera and Species of 'Challenger' Reef-Corals.* By J. J. Quelch, B.Sc. (Lond.).

Part I.

The present paper contains short descriptions of five new genera and their typical species in the collection made during the voyage of H.M.S. 'Challenger.' More complete descriptions, with figures, will be given hereafter in the 'Challenger' series, when also their affinities with fossil and recent forms will be discussed. It is sufficient in this notice to point out that *Physogyra* is to be classed with *Plerogyra*, *Napopora* close to *Synarrhœa* and *Stephanaria*, *Sandalolitha* to *Halomitra* and, perhaps, to *Zoopilus*; while *Tichoseris* and *Moseleya* may be mentioned as presenting special interest. *Tichoseris* takes a very clearly transitional place between the Lophoserinæ and the Astræidæ; while *Moseleya*, which I have had the pleasure of naming in honour of Prof. Moseley, seems to necessitate the establishing of a new subfamily of the Astræidæ to receive it—subfamily Moseleyinæ, characterized by the abundant endotheca with the dissepiments in more or less concentric circles, forming nearly complete tabulæ at the centre. The approach which it makes to the Rugosa seems to me to point to the very probable dismemberment of that group.

Moseleya, nov. gen.

Corallum compound, flattened, or slightly and broadly convex. Young calicles developing by calicinal marginal budding around a very large median calicle, which has very numerous septal orders, the calicles becoming polygonal and deep at the centre. Epitheca very slight; wall very thin and almost rudimentary, but developed so as to give a distinct simple line of separation to the calicles on the surface, often interrupted, seen in section in a very rudimentary state separating the calicinal centres. Costæ very distinct, thin, and finely denticulate. Septa often confluent and continuous from centre to centre in the line of union between adjoining calicles, very thin and close, finely toothed above, and having the teeth subequal or slightly larger near the centre. Endothecal dissepiments vesicular, very abundantly developed, leaving but a very small portion of the septa free exteriorly, seen in transverse section forming nearly concentric lines, and more or less complete tabulæ at the centre. A false columella present, seen exteriorly to be formed by the trabeculate and vermiform nature of the innermost upper part of the septa, entirely or almost absent in transverse section, where the septa are seen to meet almost at a point.

Moseleya latistellata, n. sp.

Calicles very large, the median calicle attaining a width of 6 centim., and attached by a very broad base to the surface on which it grew. Epitheca and wall very thin, the wall often rudimentary between the confluent septa of adjacent calicles. Costæ very distinct and finely denticulate above, continuing as well-marked lines to the very base. Septal system containing orders of seven cycles, but the last two cycles are incompletely developed, there being about two hundred septa in the largest calicle; the septa are very thin, finely cut into subequal sharp teeth nearly 1 millim. in length, laterally granulated and thickened chiefly in the direction of the teeth, free above only for a short portion, owing to the great development of endotheca, but at the centre the endotheca is much less developed, and consequently the calicles become much deeper and the septa more prominent. The septa of the first two or three orders are about equal and run quite to the centre; those of the higher orders become smaller and shorter, while rudiments of the highest orders are present only at the extreme edge of the calicles; with the exception of these last, the septa are regularly placed and equally raised, giving a very even appearance to the calicles, especially to the older ones. Pali and true columella absent, but the finely trabeculate edges of the septa give the appearance of a small columella.

Locality. Wednesday Island, Torres Straits, 8 fathoms.

PHYSOGYRA, nov. gen.

Corallum compound, form massive, of very light structure, having the calicles in long, sinuous, more or less mæandroid series, with their walls fused throughout so as to form a simple very thin line of separation between the series. Calicinal centres generally distinct, indicated by the curving of the septa. Costæ almost entirely absent. Epitheca very slightly developed. Septa thin, fragile, very prominent, distant, edge entire. Columella absent. Endotheca well developed, vesicular; the dissepiments continuous between the septa from the centre of the calicle to the wall, very convex above, rather far apart above each other, thus forming wide interseptal chambers. Owing to this great development of vesiculate endotheca the series of calicinal centres are separated by wide ridges, formed entirely by the thin wall and by the convex dissepiments which stretch from the centre to this thin wall.

This genus will include, besides the following new species, the *Plerogyra Lichtensteini* of Milne-Edwards and Haime; the genus *Plerogyra* being limited to those forms in which the walls are not fused together so as to form a thin lamina, but in which the series remain distinct with their walls separated, except occasionally when two free-growing ends meet and grow together.

Physogyra aperta, n. sp.

Corallum convex above; wall very thin, simple, sometimes almost rudimentary. Costæ very slightly developed, and then only at the margin of the series. The series of the calicinal centres open and shallow, in no part deep and narrow; the centres are often difficult to distinguish, owing to the uniform development of dissepiments along the series. Width of series about 16 millim., but at times more than 20 millim. The septa are 2–4 millim. apart, very thin and very projecting, subequal, except at the ends of series where some are very small, easily broken away, leaving the vesicular dissepimental ridges almost bare. The dissepiments are thin, convex above, easily broken away, about 3 millim. apart from those above or below at the wall, closer at their inner terminations, forming simple, curved, wide interseptal chambers.

Locality. Banda.

SANDALOLITHA, nov. gen.

Corallum compound, flattened, free, much elongated and very thin. Wall sparsely porous and extremely reduced; distinct costæ, closely granulated or very finely and bluntly echinulate, curving towards the short axis. Calicles few, in the long diameter of the corallum; parent calicle very large, occupying the centre, forming almost the entire corallum, with very numerous septa, there being about seven complete cycles, a much larger number of cycles being developed in the long axis of the corallum; smaller calicles very few, distinctly radiate, developing in the course of and interrupting the larger septa in the long axis of the parent calicle. The septa are crowded and very long, curving towards the short axis, and of more or less equal vertical extent, very low, giving an even laminate appearance to the corallum. Synapticula well developed and forming strong connexions at the basal parts of the septa. Columella rudimentary and trabecular.

Sandalolitha dentata, n. sp.

Corallum almost flat, irregularly sandal-shaped, fragile, translucent, being about 6 millim. thick except immediately around the mouth of the central calicle where the septa are somewhat elevated and thickened. The parent calicle attains a large size (nearly 15 centim. in length) before the smaller calicles begin to develop. Wall very thin, pierced with numerous small pores; costæ unequal, with very small granulated blunt spines, distinct, curving in radiating lines towards the short axis of the corallum except at the centre where the costal spines become crowded over a thickened circular space that seems to have been a former base of attachment. Septa of the central calicle of seven complete cycles, but incomplete orders are developed at the extremities of the long axis of as many as sixteen cycles; those of the first three cycles subequal, slightly thickened and prominent at the centre; and, with the exception of the very small ones, all the septa are nearly equally raised over the general surface, cut into strong long and narrow teeth, very granulated, especially at the apex of the teeth, which are divided into little points forming a blunt or pointed end. The septa of the higher orders unite one on each side with one of a lower order at that part of it from which they originate.

Locality. Tahiti.

TICHOSERIS, nov. gen.

Corallum compound, massive, columnar or lobate, with neither transverse calicinal ridges nor longitudinal crests, astræiform. Calicles with distinct solid walls, which are thin at their edges, but thick at their basal parts; calicinal centres arranged either singly within their own wall, or united in more or less irregular and sinuous groups of two or more incompletely separated from each other and surrounded by the common wall of the calicle from which they are developed. New calicles arise either by direct fission of a single calicle forming two separate ones with distinctly raised walls, or by the upgrowth of the synapticula at different parts of the calicle to form new walls, the resulting centres often forming mæandroid series, until the development of their own wall isolates them. Septa not at all confluent, entire, those of adjoining calicles quite separated by the raised walls. Columella absent or forming a very small styliform projection at the point of coalescence of the septa. Synapticula distant, very unequally and irregularly developed, being generally rather thick interseptal outgrowths of the wall.

Tichoseris obtusata, n. sp.

Corallum consisting of blunt, elongated, lobate masses of very dense structure throughout. Calicles small, often separate, subcircular or elongated and polygonal, about 3–5 millim. in diameter, rather deep, but almost filled up by the closely packed septa; more generally two to six or more calicles are grouped together, with their walls incompletely developed, so that they give the appearance of many centres surrounded by one raised wall, which is of very irregular shape and size, being long, sinuous, and narrow, or rounded and wide, often 5–14 millim. in diameter. Wall very solid, thin-edged above, but thick below. Septa not exsert, very numerous, in the separate calicles there are as many as five cycles, but the fifth is very incomplete; those of the first two cycles are subequal, those of the fourth and fifth very small; but all are entire, very thin above, extremely granulated or finely echinulate on their sides, with their inner edges nearly vertical. Columella very rudimentary.

Locality. Reefs, Fiji Islands.

NAPOPORA, nov. gen.

Corallum compound, porous. Gemmation intracalicinal, the developing buds with distinct centres almost destitute of distinct walls, at first united in groups of two to six, and surrounded by the common wall of the parent calicle; but as development proceeds they are separated off by a narrow, raised, distinct wall. Calicinal depressions very variable in size and shape, according to the number, position, and degree of development of the buds. Walls of the older calicles porous, distinctly raised, angular. Septa generally of two cycles, rudimentary. Pali six, sometimes one smaller than the others or absent, generally well developed, and distinctly marking the position of the calicinal centres. Columella rudimentary, represented by small papilliform projections, often absent.

Napopora irregularis, n. sp.

Corallum ramose; branches rather short, moderately thick, obtuse, and slightly or not at all compressed. Calicles very variable, seen in all stages of development, with many granular points or flattened projections; the single calicles with distinct walls, subcircular, about 2 millim. in diameter; the larger ones with many distinct centres in the same cavity, with a common wall, raised, angular, and of irregular shape, with a diameter of about 4–9 millim. Many of the developing centres present no trace of a wall, others possess walls more or less incomplete; but the centres are easily distinguished by the position of the pali. The septa of two or three cycles, generally twelve, sometimes fewer, rudimentary, sometimes rather distinct at their inner ends and united two by two where the pali are placed. The pali are six, prominent, sometimes one very small or absent. Columella inconspicuous.

Locality. Tahiti.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.

February 20, 1884.—Prof. T. G. Bonney, D.Sc., F.R.S., President, in the Chair.

The following communications were read:—

1. "On a recent Exposure of the Shelly Patches in the Boulder-clay at Bridlington." By G. W. Lamplugh, Esq. Communicated by Dr. J. Gwyn Jeffreys, F.R.S., F.G.S.

During some long-continued windy weather in the early part of the winter of 1882–83, the Boulder-clay, usually hidden by sand and shingle, was laid bare on the foreshore at Bridlington Quay. The beds thus exposed belong to the lowest recognized part of the glacial series of Yorkshire, the "Basement Boulder-clay." Over this, parted occasionally by a little sand or gravel, comes the Purple Boulder-clay, the Laminated Clay being wholly absent. The Basement Clay thus exposed contained angular and subangular boulders, with rounded pebbles occasionally scratched, besides many crushed masses of sand, sandy gravel, and clay, forming nearly a third of the whole mass. The last, which generally contained marine remains, were very variable in shape and in lithological character. The fauna of the masses varied greatly, both in abundance and in species, those common in one mass being rare or absent in another. The shells were commonly much crushed, though whole specimens occurred occasionally. The author considered that these shell-bearing patches had once formed a part of the bed of a glacial sea, which had been invaded and ploughed up by ice, which had transported them to their present locality. He gave reasons for thinking that they have not come from the immediate neighbourhood, but probably from the north-east, having been floated by icebergs to their present places.

The paper concluded with lists of the fossils discovered (obtained, for the most part, by washing parts of the included masses). The result has been that the number of the Mollusca (examined by Dr. J. Gwyn Jeffreys) has been raised from 67 to 101, five of the additions being new to science. Four species of *Balanus* and one of *Verruca* have been identified. More than eleven species of fish have been identified with more or less certainty. These, Mr. E. T. Newton remarks, seem to be either Norwich-Crag, Red-Crag, or London-clay forms; and all may have been derived from the last-named deposit. The Ostracoda and Foraminifera, which are numerous, were described by Dr. Crosskey in an appendix.

2. "On the so-called *Spongia paradoxica*, S. Woodward, from the Red and White Chalk of Hunstanton." By Prof. T. McKenny Hughes, M.A., F.G.S.

The author described a branched structure found in the Red and White Chalk of Hunstanton, which was named *Spongia paradoxica* by S. Woodward, and has since generally been known as *Spongia* or *Siphonia paradoxica*. The beds in which this supposed sponge occurs, contain fragments of various organisms, including sponge-spicules, but no trace of structure can be found in sections of the *Spongia paradoxica*. The fragmentary state of the undoubted organic remains would indicate that they were drifted into their present position, and therefore a state of things quite unfitted for the growth of a slender branching sponge; the so-called sponge commonly occurs in layers along the bedding-planes, but frequently rises through the whole thickness of one bed and extends up into the overlying layers. It does not seem likely that it was the root of a *Siphonia* or some similar organism. Another body which has been also called *Spongia paradoxica* consists of masses of more crystalline texture, exhibiting upon weathered surfaces a network of small ridges enclosing cup-like depressions. These appearances were compared by the author to the weathered surfaces often seen in certain beds of the Mountain Limestone and in gypsum; the masses show no traces of internal structure.

The author stated that sections of these bodies show exactly the same characters as the containing rock, except that the material is more compactly crystalline; it contains the same fragments of shell, &c., and the same sand and pebbles. He regarded them as of concretionary origin, and explained their symmetry of form and regularity of arrangement by their being formed at the intersections of joints with the bedding-planes or with one another. Phosphatic nodules occur in the lower parts of the White Chalk, and had these bodies been sponges they would probably have been phosphatized; but analyses have shown no marked difference in this respect between their substance and that of the surrounding rock.

March 5, 1884.—Prof. T. G. Bonney, D.Sc., F.R.S., President, in the Chair.

The following communication was read:—

1. "On the Structure and Formation of Coal." By E. Wethered, Esq., F.G.S., F.C.S.

The author, having referred to the work of previous investigators, pointed out that seams of coal do not always occur in one bed, but are divided by distinct partings, some of which, as in the case of the Durham main seam, contain *Stigmariæ*. It was important to notice this feature for several reasons, but especially as the beds of coal, defined by the partings, showed differences both in quality and structure. In the case of the shallow seam of Cannock Chase they had at the top a bed of coal 1 foot 10 inches thick, the brown layers of which were made up of macrospores and microspores. The bright layers were of similar construction, except that wood-tissue sometimes appeared, also a brown structureless material, which the author looked upon as bitumen. He, however, objected to that term, and thought that hydrocarbonaceous substance would be preferable. What this hydrocarbonaceous material originated from was a question for investigation. In the lower bed of the Welsh "Four Feet" seam wood-tissue undoubtedly contributed to it; whether spores did was uncertain; it was true they could be detected in it. In the second bed of the shallow seam they had a very different coal from the upper one. It was made up almost as a whole of hydrocarbonaceous material. Very few spores could be detected. It was possible that the scarcity of these objects might be due to decomposition; but the author's investigations seemed to show that spores resisted decomposing influences more effectually than wood-tissue, which seemed to account for the fact that where they occur they stand out in bold relief against the other material composing the coal. Below the central bed of the shallow seam came the main division. In it the author detected a large accumulation of spores, but hydrocarbon formed a fair proportion of the mass. The author referred to other seams of coal from various parts of England, and pointed out the structure of each bed composing them. The conclusions on the evidence elicited from his investigations were (1) that some coals were practically made up of spores, others were not, these variations often occurring in the beds of the same seam; (2) that the so-called bituminous coals were largely made up of the substance which the author termed hydrocarbon, to which wood-tissue undoubtedly contributed.

An appendix to the paper, written by Prof. Harker, Professor of Botany and Geology at the Royal Agricultural College, Cirencester, dealt with the determination of the spores seen in Mr. Wethered's microscopic sections. Taking the macrospores, the resemblance to those of *Isoëtes* could not fail to strike the botanist. He had procured some herbarium specimens of *Isoëtes lacustris* in fruit, and compared the spores with those from the coal. When gently crushed, the identity of the appearance presented by these forms from the coal was very striking. The triradiate markings of the latter were almost exactly like the flattened three radiating lines which mark the upper hemisphere of the macrospores of *Isoëtes lacustris*. The writer therefore concluded that the forms in the coal were from a group of plants having affinities with the modern genus *Isoëtes*, and from this Isoëtoid character he suggested for them the generic title of *Isoëtoides* pending further investigation.

BIBLIOGRAPHICAL NOTICES.

Notes on Natural Selection and the Origin of Species. By FRANCIS P. PASCOE, F.L.S. London, 1884. Taylor and Francis.

MR. DARWIN having outlived the unreasoning rancour of his early critics, his works are likely for some time to come to form the text for much useful, thoughtful, and no doubt, in many cases, well-founded criticism truly so called. Mr. Pascoe's 'Notes' belong to this latter category. He admits that "no naturalist in these days doubts that species have arisen by modifications through descent;" and he offers no suggestion as to the fixation of specific characters by any means except natural selection. His object is simply to point out various classes of difficulties in the way of the acceptance of this, which is after all *the* Darwinian theory, and, in addition to apparently endorsing many of Mr. Mivart's criticisms, to insist on the view that all the characters which serve to differentiate species are "unimportant except as incipient structures, to which, as yet, no advantage can be attached." This difficulty, and it is a weighty one, is, in the present writer's opinion, partly owing to the unfortunate prominence given to the indefinite, subjective term "species" in the title of Mr. Darwin's great work. It is apparently forgotten that a "species" is not so much a series of forms similar in their main positive characters as a series isolated from other series by negative characters—in the language of logicians, "*genus et differentia*." Hence the problem of the origin of species is not one of the acquisition of positive characters, but deals with the isolation of groups of variations by the extermination of forms intermediate between the variations of one geological age and those of another. It is not the origin of specific characters, but of specific divergence or difference. Hence, admitting, as one undoubtedly must, that the positive diagnostic characters of species are very generally indifferent from the point of view of utility, they may yet have well become characteristic by the extermination of intermediate stages which may very probably have been harmful to the organism.

No one can deny the existence of a keen struggle for existence, and surely it is no "assumption" to state that in this struggle the weakest must succumb. Incipient structures being small, make but small demands upon nutrition, and may well therefore be indifferent. More advanced intermediate stages will make greater demands, and, being less perfect, will, in competition with more completely specialized structures, be actually harmful.

Nevertheless it may be admitted that whilst Mr. Darwin never professed to explain variability by the theory of natural selection, he may not have sufficiently recognized the universality of indifferent variations. Heredity, towards the explanation of which Mr. Darwin merely threw out the hypothesis of pangenesis, would, of course, perpetuate these indifferent characters, as it does useful and harmful ones. On the Darwinian theory, the persistence of lowly organized types, of useless or even harmful structures, and of imperfect adaptations, is perfectly explicable, as is also the existence of a variety of structures to serve one purpose, or conversely that of one organ serving divers purposes. These, together with the varied forms of Radiolaria or Foraminifera on which Mr. Mivart insists, are simply cases of the absence of a struggle or of its slowness in producing extermination. Such persistent forms as *Nautilus* and *Lingula*, to which Mr. Pascoe alludes, and to which we might probably add the soft-bodied *Peripatus* and *Amphioxus*, are after all but few in proportion to the immense number of extinct species, and their existence is but a lingering one, "far from the madding crowd;" and whilst no doubt, if looked at as worms, the two latter may be termed "extremely specialized," considered as Arthropods or Vertebrates they are certainly not so.

These cases of persistence suggest what appears to be some answer to Mr. Mivart's hypothesis, "that specific differences may be developed suddenly instead of gradually." External conditions do not, as a rule, change rapidly. The rise and fall of land, changes in climate, or in the characters of aqueous sediments, are in the main gradual. A sudden variation will be of the nature of a monstrosity and but little likely to occur similarly and simultaneously in many individuals. The chances are also apparently against its being so well adapted to its surroundings as its slowly adapted congeners. The case adduced by Mr. Mivart of the change of *Siredon* into *Amblystoma* is not the origin of a new but the reversion to an old form; and possibly the Ancon sheep would not have been perpetuated in a wild state. The latter is an illustration of the increased variability of forms when domesticated, a result that might well be anticipated from the unnatural suddenness of man's changes in their surroundings inducing a condition of unstable physiological equilibrium. It was with reference to such views as to sudden changes that Mr. Darwin wrote, "Slight individual differences, however, suffice for the work, and are probably the sole differences which are effective in the production of new species." This sentence Mr. Pascoe apparently misunderstands as representing natural selection as the sole cause of the origin of new species.

It is in many cases difficult to gather how far Mr. Pascoe endorses Mr. Mivart's objections, and space only permits a brief reference to three of these, viz. highly specialized structures, the absence of "infinitely numerous fine transitional forms," living or extinct, and the "polyphyletic hypothesis." The first of these was fully dealt with by Mr. Darwin, who showed for example that even the human eye is an imperfect instrument, and that among the lower animals we have a very large series of transitional forms of eye, from a mere nerve-ending epithelium cell to the eye of a *Nautilus*, of a lobster, or of a man. So, too, we must join issue with Mr. Mivart as to the absence of extinct transitional forms. The progress of geology even since Mr. Darwin wrote has added enormously to our knowledge of such forms, whilst it has also shown that it is difficult to overstate the imperfection of the geological record. In the face of such cases as those of the Ammonites described by Würtenberger and of *Planorbis multiformis* in the Steinheim Limestone, described by Hilgendorf, it is difficult to say that "the mass of palæontological evidence is indeed overwhelmingly against minute and gradual modification." Of course these evidences have often, as Häckel has shown, been evaded by arguing in a circle as to wide specific limits and limited variability; but this only demonstrates the meaninglessness of the term "species."

To imagine that the characters of two sets of organisms can so have varied as to produce in distant regions the same result is surely a greater violence to the ordinary laws of causation than to suppose that an organism now found in two such regions has previously existed in the area intervening between them. Like causes may produce like effects; but in the complexity of organic life and its surroundings can causes ever be sufficiently like for this polyphylesis?

Mr. Pascoe's pamphlet suggests many other topics of interest in matters of detail, as, for instance, why man's action should be excepted in discussing the recent extermination of species; but perhaps its chief merit is in the frank statement of difficulties and of arguments *pro* and *con* without any attempt to set up any agency as an alternative to natural selection. "A tendency to be wingless" or any other "tendency" is, it must be remembered, only a statement, and not even an approach to an explanation.

G. S. Boulger.

Phytogeogenesis. The Primæval Development of the Crust of the Earth and of Plants. Sketched out by Dr. Otto Kuntze. Pp. 213. 8vo. Leipsic: 1884. [*Phytogeogenesis. Die vorweltliche Entwickelung der Erdkruste und der Pflanzen in Grundzügen dargestellt von* Dr. Otto Kuntze.]

The special objects of consideration in this treatise are the formation of the primæval rocks from gasogenous glowing crystals, the gradual salinity of the ocean, and the marine development of the coal-plants. Having laid down his principles for the reconstruction of primæval conditions and his hypothesis on the origin of the first beings, indicating that fecundation is an originally morbid phenomenon, and treating of the probable origin of the first organic cells, the author proceeds to the consideration of the characteristics of the successive geological periods:—I. Inorganic, beingless, lifeless, or hidden-life (cryptobiotic) periods. No fossils; volcanic products without steam-cavities and glassless, and eruptions not dependent on water. 1. First, anhydrate, waterless, or sealess period (Primæval Gneiss): $\pm 1000^\circ$–300° C. Sedimentary spheroidal formations (volcanic bombs, granite nodules) by glowing crystallized precipitates from the atmosphere, and their coagulation into primæval rocks destitute of hydrated minerals. 2. Second, thermohydrate or hot-sea period (Huronian): $\pm 300^\circ$–130° C. Hot calciferous seas and aqueous cementation of the minerals left unconsolidated after the first period. 3. Third, unfossiliferous and early-being, or cryptobiotic (hidden-life) period (Clay-slate): $\pm 130^\circ$–140° C. Origin of the first animate existences, which were not, however, preserved fossil. Rock-formation scanty, microcrystalline.

II. Visible-life (phænobiotic) or fossiliferous periods. Fossils present; volcanic products dependent on water, with the hardness of the earth's crust greater, the ocean's saltness decreasing, and steam-cavities and glass-inclusions increasing. A. Azonal or zoneless-sea periods. No climatal zones nor continental climate. Flora and fauna confined quite or almost to the tranquil sea, which is full, since the still warm earth-crust absorbs but little water. The clastic sediments quickly conveyed from the naked and relatively small continents to the sea, and but slightly broken. The absence of atmospheric carbonic acid permits of only a marine flora. 4. Fourth, or algo-marine period (Silurian): $\pm 40^\circ$–30° C., $\frac{1}{4}$ *per cent.* of saline contents in the sea. Luxuriant marine algal flora, with a rich marine fauna, especially of calcareous animals. 5. Fifth, or prato-marine (sea-meadow) period (Devonian): $\pm 30^\circ$–25° C., $\frac{1}{2}$ *per cent.* of salt in the sea. Luxuriant, meadow-like, floating marine flora. Fishes, but of a freshwater character, plentiful. Borne or growing up above the water, the marine algæ become by this supermarine habit vascular-cryptogamic, and also more suitable for the formation of coal. 6. Sixth, or sylvo-marine (sea-forest) period (Carboniferous, in part): $\pm 25^\circ$–15° C., as much as 1 *per cent.* of salt in the sea. The supermarine flora is more developed and woody; with the first plants having aerial fructification. The rootless *Lepidosigillariæ* simply float. On the shore a woody, rooted, shallow-water flora is developed, with at last the first land-plants. Coal-beds are formed abundantly by the sinking of the decaying supermarine plant-remains to the bottom, if clay-beds lie upon and tend to preserve them; or there remains the Coal-Limestone separated by the sea-plants. By the exhalation of the supermarine forest the air becomes charged with carbonic acid, and thence the possibility of a terrestrial flora. 7. Seventh, or sea-shore (marine littoral) period (Dyas or Permian): $\pm 15^\circ$ C., up to $1\frac{1}{4}$ *per cent.* of salt in the sea. The supermarine flora nearly dies out; the littoral flora increases. Angiosperms in the 6th and 7th periods.

B. Land-zonal periods. Zones of climate, continental climate, and unquiet shallow seas. Plants and animals are developed on the increasing land; but in the sea they are changed or destroyed by its saltness, calcareousness, cooling, and restless surface. The continually increasing land-flora causes permanent rivers, hinders the passage of the clastic products considerably, favours their decomposition, and consequently the increase of salt and lime in the sea. With the development of terrestrial fauna and flora the proportion of carbonic acid in the air is raised, and land-plants increase. 8. Eighth, or dizonal-littoral (two-zoned littoral) period (Mesozoic). Broad mid-zone tropical; polar zones subtropical: $1\frac{1}{4}$–2 *per cent.* of salt in the sea. Flora and fauna more limited to the shore and neighbourhood of inland waters. 9. Ninth, or dizonal-continental period (Tertiary). Tropical mid-zone and temperate polar zones: up to 3 *per cent.* of salt in the sea. Flora and fauna more continental. The shiftings or derangements in the crust of the earth reach their maximum. The greater cooling causes great variability in plants. The origin of man, at first black only, dates from this 9th period. 10. Tenth, or three-zoned (trizonal) period (Quaternary). Hot, temperate, and cold zones. Development of the existing conditions.

The main principles and very much of the details on which the foregoing classification of the geological periods and orders of nature has been founded by the author are treated of in Chapters IV.–XI. Thus:—the climatic interpolations of the geological periods, the progressive salinity of the ocean, the absence of salt or muriatic acid in the inclusions of the last-formed primary quartz, the passing of fish from fresh to saline water, the sea containing in early times some phosphate of lime and more of lime than soda, the salinity of fresh water, geological time, the Caspian anciently freshwater, the gradual decrease of lime in the sea, carbonic acid in the economy of nature past and present, hypotheses of the developmental condition of early marine beings, the relationship of the oldest recognizable land-plants to sea-weeds, the genealogy of the vegetable kingdom (table, p. 140), the differences between Monocotyledons and Dicotyledons explained by their developmental history, carbonaceous sediments in the sea, proofs of the oceanic life-habits of all coal-making plants, and refutations of erroneous hypotheses of the formation of coal. This last subject is very fully treated in Chap. XI. under more than forty headings. Arguing throughout on premises of his own making, the author satisfactorily arrives at his own conclusions, which are far from being in accordance with the views of geologists and botanists of the present day.

MISCELLANEOUS.

On the Operculum of the Gasteropoda. By M. Houssay.

In 1825 Blainville wrote, in his 'Manuel de Malacologie,' as follows:—

"The operculum is evidently the production of the skin which covers the foot. . . . But how does a flat oval or circular surface produce a material which rolls into a spiral, often in a very regular manner, and sometimes forming a great number of turns? It is a question which it really seems to me very difficult to answer, perhaps especially because it has not been sufficiently studied."

In 1829 Dugès endeavoured to fill up this gap, but, considering only opercula detached from the animals, he arrived at the false conclusion that the operculum is a production of the mantle. The authors who have followed him have scarcely attempted to do more than try to find out with what part of the Acephala the operculum was homologous; but, as they had no basis for their argumentation, they arrived at the most contradictory results, some regarding it as the homologue of the second valve of the Lamellibranchs, others, like Lowén, comparing it with the byssus.

The foot alone is implicated in the formation of the operculum, and I have set myself to determine precisely what parts of this organ excrete the material, and how the growth of the operculum takes place. Contrary to what is generally supposed, I have ascertained that the whole surface of the foot does not take part in the production, but only a very clearly defined small portion.

I shall give the name of the *columellar margin* of the operculum to that which lies on the side of the columella when the animal is withdrawn into its shell, and that of *parietal margin* to the opposite part. The operculum presents an internal and an external surface: it is necessary to distinguish them, as they have not the same mode of formation.

Let us first of all see to the external part. It presents on its surface striæ of variable form according to the genera under examination. On examining carefully a *Littorina*, a *Murex*, or a *Purpura*, we observe, quite close to the columellar margin of the operculum, a small transverse fissure which penetrates about 1 millim. into the thickness of the columellar muscle, and which occupies the whole length of the foot. The walls of this pedal fissure are lined with a peculiar epithelium, folded, or rather goffered, so as somewhat to resemble the polypary of a *Mæandrina*. We see within it a very delicate and very flexible transparent lamella. With a fine needle this lamella may be taken out, when after remaining for some time in the air, it dries and acquires a horny appearance.

By making sections we find that the epithelial cells of the fissure excrete a structureless material, of a yellowish colour, and strongly refractive, which, by agglomeration, constitutes the hyaline lamella. The latter issues from the pedal fissure and adds itself to the old operculum.

The newly formed parts apply themselves to the epithelium situated between the fissure and the parts of the operculum which are already fixed. At this point the epithelial cells are but feebly adherent to each other, and only by their basal part, a remarkable exception among epithelia. From this it results that the still plastic opercular material invests these cells, and even diffuses itself somewhat among the elements of the subjacent tissues (muscular fibres and connective cells). It is thus that, by successive appositions of new parts issuing from the pedal fissure, the striæ are formed, of which only the most salient are visible to the naked eye or the lens.

On the other surface of the operculum we must distinguish two regions, the surface of insertion of the columellar muscle, and the free internal surface. It is very easy to see that the free inner surface and the outer surface of the operculum have not the same constitution. The inner surface is covered with a homogeneous layer which forms, as it were, a varnish without any striæ perceptible to the eye. This coating may even be so thick that we cannot see through it the striæ of the other surface (*Murex*). In other cases it is delicate enough not to hide them (*Littorina, Trochus*). This difference of constitution arises from a difference of origin. In front of the surface of insertion the metapodium forms an anterior expansion or lip, which, during the life of the animal, is constantly applied against the inner unattached part of the operculum. The epithelial cells of this anterior lip produce the varnish.

It still remains to ascertain why the opercular material is rolled into a spiral. To elucidate this point we must study the muscular impression. As the operculum grows, the surface of insertion of the operculum is displaced with a slight movement of rotation, since during the same time the shell grows in a spiral. The muscle attaches itself to the newly formed parts, abandoning the old parts on the side of the parietal margin. These stages of the columellar muscle are marked by striæ independent of those of the superior surface. We observe them when preparing an operculum after removing all traces of muscle. By studying these lines we can even understand why there are opercula of which the form always remains the same, while there are others of which the form varies with the age of the animal. The latter are said to have a *nucleus of formation*. The posterior secreting portion of the foot always retains the same form in the first case, whereas in the second we see it from nearly circular become almost straight.

Thus we see that the operculum is a production of a definite portion of the epithelium of the foot, and appears to be very different from the byssus of the Acephala, which is produced by a highly developed gland occupying a good part of the volume of the foot. It is still more different from the second valve of a shell.—*Comptes Rendus*, January 28, 1884, p. 236.

A Fungus infesting Flies.

Prof. Leidy directed attention to a vial filled with flies adherent to fragments of leaves. He stated that on the 1st of August, the last summer, he had noticed that from the swarm of flies that were attracted by the ripe fruit of a black mulberry, *Morus nigra*, many settled on the underside of the leaves, and there became fixed and died from the invasion of a fungus, in the same manner as the house-fly often becomes attached to walls and window-panes, in the autumn, through the agency of the fungus known as the *Sporendonema*. The infested flies on the mulberry-tree were so numerous, that perhaps a fourth of the foliage of the lower boughs had from one to half a dozen of the flies adherent to each leaf. The fly, though a familiar one, is unknown by name to him. It resembles the house-fly, but is larger and has a black abdomen, with lateral whitish spots. The fungus, of a fuscous hue, is especially evident in the extended intervals of the segments of the abdomen, along the sides of the thorax, and at the neck. Though extending to and attaching the flies to the leaves, the specimens no not exhibit the zone of spores on the leaf, as commonly seen in those of infested house-flies. Microscopic examination exhibited a similar structure of the fungus to that of the *Sporendonema* or *Empusa muscæ*. It mainly consists of translucent cylindrical, straight or somewhat tortuous rods or tubes of variable length with rounded ends, and containing homogeneous liquid with rows of oil-like globules. Mingled with the tubes are numerous oval, ovoid, and pyriform spore-like bodies, usually each with two oil-like globules. The spore-like bodies measure 0·028 to 0·036 millim. long by 0·016 millim. thick. The longer tubes measure usually up to 0·16 millim. long by 0·012 millim. thick.—*Proc. Acad. Nat. Sci. Philad.*, Dec. 1883, p. 302.

On the Occurrence of Colobus Kirkii.

We have received the following communication from Sir J. Kirk regarding this monkey ; it is dated from Zanzibar, Feb. 16th :—

"In the Proc. Zool. Soc. Feb. 1868, p. 27, Dr. Gray described a new *Colobus*, and named it after me. That monkey then was rare, but still to be had in many of the wooded districts of this island. I am not aware that it has been found in Pemba Island or on the mainland ; and now I discover that, if not extinct, it has become so rare as not to be procurable, even when I sent the hunters over the island. I have a report that it exists still in one spot which they could not reach. I think two specimens were sent to Germany some time ago ; but it looks as if the animal will be lost. This is due to the destruction of forest and jungle over the island."

Polythalamia from Inland Salt Water in Hungary. By Dr. Eugen von Daday.

The author has found, in a mass collected from a salt pool near Déva, in Transylvania, examples of Polythalamia, the shells of which show no traces of calcification, but consist of a yellowish chitinous substance, on the surface of which numerous little plates of quartz adhere. Probably the Polythalamia found near Déva are the representatives of a living continental species ; but the author leaves this to be settled by further investigation.—*Math. naturwiss. Berichte aus Ungarn*, Bd. i. p. 357.

On the Sexual Differences of Corœbus bifasciatus, *and on its supposed Ova.* By M. A. Laboulbène.

The Buprestid, *Corœbus bifasciatus*, which is exceedingly injurious to the evergreen oak in the south of France, has been reported upon by MM. Régimbeau * and De Trégomain †. The author finds that the organ described by these writers as an ovipositor is in reality the male organ! The female *Corœbus* has a simple oviduct.

M. Régimbeau describes certain bodies as ova, most of which the author regards as fæcal masses; while M. de Trégomain notices the occasional presence in the galleries in which the beetles undergo their metamorphoses of great quantities of eggs, "some nearly spherical, others somewhat oval, about 0·07 millim. in diameter, of a yellow colour, and slightly translucent." In some cases these eggs presented "whitish lineaments." M. de Trégomain thinks that if they are the ova of *Corœbus* they must be unfecundated, as the insect is always alone in its gallery.

The author confirms the description and figures given by M. de Trégomain, and adds that he has found upon pupæ which died before completing their metamorphosis oviform bodies, varying in size from $\frac{1}{3}$ millim. to 0·82 millim. They were of an amber colour, and some of them presented whitish lines and even spots. These, he thought, could not be true ova, and rather believed that they were vesicular Ascomycetous Fungi developed upon the dead insects; and the microscope showed a few filaments of mycelium.

He goes on to say:—"On observing these oviform bodies with the microscope, I constantly found with them some Acarina perfectly recognizable by their rostrum, legs, &c. Further, these oviform bodies, when crushed or subjected to the action of various reagents (prolonged maceration in glycerine, staining in carmine), showed in their interior true ova in various stages of development. The smallest of these ova were rounded; the largest had acquired an elliptical form; their average size was in the greatest diameter 0·10 millim. and in the other 0·075.

"Carefully examining the position of the mite relatively to the oviform bodies, I ascertained many times (with M. Rémy, chief of the Laboratory of La Charité) that the posterior part of the body of the mite was prolonged into a globular abdomen, and was attached to it by chitinous rods. The oviform body was in reality only the abdomen more or less vesicularly dilated, strengthened by chitinous threads, three on each side, and filled with the ova of a mite, attached to the pupa of the *Corœbus*.

"The conclusion that forces itself upon one is as follows:—A mite (the species of which will be hereafter determined, and which is allied to *Tyroglyphus*) occurs in the galleries upon dead pupæ of *Corœbus bifasciatus*. This mite is remarkable because its abdomen becomes dilated into a large vesicle and filled with ova. The abdo-

* 'Le *Corœbus bifasciatus*, ou Bupreste ravageur du Chêne vert' (1876).
† 'Les Insectes du Chêne vert' (1876).

minal development, which is peculiar to this Acarine, and has not previously been indicated in the Arachnida of this group, resembles that occurring in the female termites, and especially in the females of the Chigoe (*Dermatophilus* or *Pulex penetrans*) of the tropics."—*Comptes Rendus*, February 25, 1884, p. 539.

New Contributions to the Knowledge of the Rotatoria. By Dr. Eugen von Daday.

After devoting several years to the study of the Hungarian Rotifera, especially those of Transylvania, the author in 1882 visited the group of pools in the Mezöséy, and found in the Mezö-Záher pool several new species, one of them representing a new genus. The following are the characters of these new forms:—

Genus Brachionus, Ehr.

Brachionus Margói, n. sp.

Testula lævi, oblongo-ovata; frontis dorso processibus quatuor, mediis longioribus, basi inflatis, acutis; lateralibus brevioribus, arcuatis; ventri margine undulata, medio excisa; postice utrinque latere processu longo, acuminato ac valde arcuato; apertura pedis bidentata. Long. corp. 0·5–0·8 mill.

Collected on the frothy surface of the large pool near Mezö-Záh, where it occurred pretty abundantly with small Crustacea and the following Rotifera. It most nearly approaches *Brachionus amphiceros*, especially as regards the processes of its carapace; but in that species the processes are all of equal length, while they differ in length in the new one. The essential distinction between the two species is to be sought in the rotatory organ, the musculature, the jaws, and salivary glands. The new form is named in honour of Prof. T. von Margó.

Genus Schizocerca, n. gen.

Novum genus e Brachionorum familia; testa lævi; oculis duobus conjunctis sessilibus; pede longo, cylindrico, apice magnopere fisso, furcam longam efficto, ramis apice dentibus duobus inæqualibus instructis.

Schizocerca diversicornis, n. sp.

Species unica, charactere generis. Corpore elongato, fronte latiusculo, postice parum attenuato; testa lævi, frontis processibus quatuor, mediis parvis, basi inflatis, marginalibus elongatis, acutis, arcuatis; ventri margine medio excisa; mucronibus duobus posticis inæqualibus, dextro multo longiore, acutiore inflexoque, sinistro breviore, latiore. Long. corp. 0·15–0·2 mill.

Occurs frequently in the pool of Mezö-Záh. Resembles *Brachi-*

onus in internal organization, but differs so much from the Brachionea, and, indeed, from all Rotatoria, in the structure of its foot, that the author regards it as the type of a new genus.

Genus Asplanchna, Gosse.

Asplanchna triophthalma, n. sp.

Corpus truncato-ovatum; ocellis tribus, duobus marginalibus, uno majore collari; organo rotatorio simplice, parum undulato; fronte organis tentaculatis; pede anoque caret. Long. corp. 0·8–1·2 mill.

This is also found abundantly in the froth of the surface of the great pool near Mezö-Záh. It is one of the largest of Rotifera, and very similar to *Asplanchna Sieboldii* (*Notommata Siboldii*, Leyd.) in the form of the body, the digestive apparatus, and the ovary. But the nervous system, the aquiferous vessels, and the construction of the rotatory organ show such considerable differences that the author has no hesitation about separating the two species, and he gives the new one the name of *Asplanchna triophthalma*, because besides the frontal eye, seated upon the œsophageal ganglion, it possesses two other smaller eyes placed at a distance from the ganglion and provided with visual nerves. The male of *Asplanchna Sieboldii* possesses on each side of its body a triangular process; but no such appendages occur in the male of the new species.—*Math. naturwiss. Berichte aus Ungarn*, Bd. i. p. 261.

On the Development of the Comatulæ. By M. E. Perrier.

To arrive at a strict determination of the different parts which constitute an adult *Comatula* we have endeavoured to ascertain, by means of materials kindly furnished to us by Dr. Viguier, of Algiers, what is the organization of the animal at the three phases:—1, of *Cystidean*; 2, of *Pentacrinus*; 3, of free *Comatula*, but not yet adult.

1. At the close of the Cystidean phase the young *Comatula* still possesses only buccal tentacles and no arms. Its digestive tube forms a half spiral, and presents an anus situated upon the side of the body. Around the mouth there is an annular canal into which the buccal tentacles open. A short tube, bent into a V, starts from the annular canal, traverses the wall of the body, at the same time slightly changing its structure, and becoming united with the surrounding tissues, and then opens exteriorly by a pore situated upon the wall of the body. This tube has been compared with the hydrophorous canal of the Holothuriæ, which is itself regarded as homologous with what is called the *sand-canal* in the Sea-urchins, Starfishes, and Ophiurans. It serves indubitably to introduce water into the tentacular apparatus; but we must make the most express

reservations as to its homology with the sand-canal of the other Echinodermata.

The peduncle of the young animal contains six cellular cords—one central and five forming around the central cord the edges of a pentagonal prism, the axis of which it would occupy. The central cord is prolonged into the inflated part of the body, in such a way as to occupy the axis of the spiral formed by the digestive tube, and its cellular walls become thickened so as to form an ovoid body, the large cells of which, in sections, are always arranged in two contiguous series, so that the ovoid body is filled up. This body is surrounded by a fibrous envelope, and becomes united at its upper part with the wall of the pharynx. It occupies exactly the same position, relatively to the digestive tube, as the sand-canal of the Sea-urchins.

The five cords which surround the axial canal are slightly inflated at their entrance into the body properly so called; a cavity makes its appearance in their inflated region; from this results the formation of five chambers, which constitute the first trace of the *chambered organ*. Cellular buds, starting from the apex of these chambers, soon arrive, by creeping along the walls of the body, at the circumbuccal canal; the latter forms a bud at the point of meeting; the two buds then bear towards the exterior; the wall of the body forms a sort of cap for them, and all these parts, increasing in size together, finally constitute an arm. The five arms do not make their appearance simultaneously, but successively, and still continue to show great difference of size during nearly the whole duration of the following phase. Their growth is executed from the commencement as indicated in our communication of the 16th July.

2. The Pentacrinoid phase extends from the appearance of the arms to the complete formation of the cirri. At this moment, in consequence of the development of the arms, the oral surface of the larva, which was at first entirely occupied by the tentacular ring, has become considerably enlarged, and the anus has been shifted into it; it opens henceforward at the apex of a special tube. This surface is cut up into five sectors by the tentacular canals, which run towards the anus. Upon each of these sectors there is seen a hydrophorous orifice, resembling the single orifice of the preceding phase, and to each of these five orifices there corresponds a hydrophorous tube. In sections these five tubes appear to terminate by a free extremity in the general cavity; but we have reason to think that these tubes are normally in continuity with the five canals which traverse the wall of the body to terminate at the five hydrophorous orifices.

The ovoid body which traversed the axis of the general cavity has now the aspect of a double canal, the two parts of which seem to open into the pharynx, a point, however, which still needs further investigation. The chambered organ has acquired very nearly its definitive form. At its level, in those individuals of which the arms are not yet much developed, we see originate from the central peduncular cord clavate buds alternating with those of the arms. These buds, taking a direction downwards and outwards, soon reach the integuments. The latter become inflated and elongated over them, and then these various parts, growing together, finally constitute a cirrus. The cirri consequently have no true homology with the arms; they originate from the central cord of the peduncle, and the arms from the five peripheral cords. At this age there is no trace of a vascular apparatus, and the axial organ retains very nearly the histological structure of the ovoid organ of the preceding phase.

3. At the moment when the young *Comatula* becomes detached the digestive tube has formed new folds around the axial organ. The hydrophorous tubes have considerably increased in number; but we observe the same relations between them and the canals which traverse the wall of the body to open externally. The axial organ has still the exclusively cellular structure which it has constantly presented up to this point; but its walls bend inwards into rolled lamellæ which pretty closely remind one of the arrangement of the sand-canal of the starfishes. This organ terminates below in a conical tube, which, constantly narrowing, penetrates into the axis of the chambered organ.

The trabeculæ of connective tissue of the general cavity are very numerous, and some of them which are attached to the envelope of the axial organ might be taken for vessels, but there exists nothing that can be designated by that name. Through the vacant spaces which exist between these trabeculæ there run a few solid cellular cords which indirectly pass to the arms. The cellular tissue which envelopes the chambered organ is extremely thick and has quite the aspect of a tissue engaged in rapid multiplication. This tissue is produced into the centre of the calcareous axis of the arms, and already presents all those connexions which we have formerly described with the muscular tissue and the connective tissue of the arms.

To sum up, at this age the pores which place the general cavity in communication with the exterior may be regarded as the orifices of hydrophorous tubes, with which they are connected at once by their number and position; these tubes, perhaps homologous with those of the Holothurians, by no means correspond to the sand-canal of the other Echinodermata; this sand-canal, on the contrary, seems to be represented by the axial organ of the *Comatulæ*, which possesses at once the structure of the sand-canal of the starfishes and the position of the organ of the same name in the sea-urchins. This organ is evidently in relation with the nutrition of the cirri, the origin and nature of which are very different from those of the arms.—*Comptes Rendus*, February 18, 1884, p. 444.

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XXXV.—*The Classification of the Animal Kingdom, with reference to the newer Zoological Systems.* By Dr. T. Margó *.

The sum of our knowledge of the anatomical and histological structure as well as the development of different animals has advanced of late years with wonderful rapidity. In accordance with this the views of zoologists as to the classification of the animal kingdom have also changed continually. It is therefore no wonder that with such frequent alterations of the system younger naturalists, who may be inclined to regard the system as the foundation of the science, find themselves at first in no small difficulty, until, subsequently, after they have penetrated more deeply into the interior of nature, and recognized the essence of zoology more accurately, they arrive at the right view, that in reality classification or taxonomy is by no means the foundation of the science, but rather only the roofing-in of the structure raised upon the foundation of morphology and embryology.

As the main cause of the vacillations nowadays apparently occurring in classification we must undoubtedly regard only

* Translated by W. S. Dallas, F.L.S., from the 'Mathematische und naturwissenschaftliche Berichte aus Ungarn,' Band i. pp. 234–260 (1883).

the enormous advance lately observable in the domain of morphology and embryology, an advance which from year to year becomes more and more evident by the discovery and exact observation and demonstration of new facts of great importance to science, which naturally lead to changes, modifications, and rectifications of opinion. From this it is easily understood why we meet with different systems in the different treatises and manuals of zoology, and how, even with the same naturalist, the system may change essentially from time to time.

Thus, for example, Huxley's system of the year 1875 is essentially different from that followed by him at a later period (1878); for while this naturalist formerly adopted the formation of the embryonal nutritive cavities, the mouth, and cœloma as the foundation for a phylogenetic grouping of animals, and accordingly divided the Metazoa into Archæostomata and Deuterostomata, and the latter again, in accordance with the mode of formation of the cœloma, into Enterocœla, Schizocœla, and Epicœla, and consequently the whole animal kingdom into twenty-six stems or phyla *, the same author, some years later, leaving the phylogenetic point of view and the descent of animals entirely out of consideration, divided the whole animal kingdom, exclusively from morphological types, into eight large typical groups. We find similar alterations also more or less in the classifications of Gegenbaur, Ray Lankester, Claus, &c.

Further vacillations of many kinds may also be produced in the system by the circumstance that the individual views of the different naturalists as to the value and usefulness of the facts ascertained by observation sometimes do not exactly agree, by which means the combinations and deductions from those facts may often lead to quite different final results. But if we consider not so much these combinations, but rather the already ascertained facts which constitute the proper subject, the true foundation of classification, we come without much difficulty to see that the systems, however different they may be, nevertheless contain many generally admissible truths, which are raised beyond the least doubt.

We may consider animals like all other natural objects—treat them systematically or group them from different points of view, and combine them at pleasure into a system. Every zoological system, if it be objective and founded upon already demonstrated facts, has its justification, and when considered from a certain standpoint may have its value and use. Thus,

* Huxley, "On the Classification of the Animal Kingdom," in Quart. Journ. Micr. Sci., January 1875.

as is well known, there are *Natural-history systems*, such, for example, as the systems of the old school, which were chiefly founded upon the external form and vital relations of the animals. There are systems chiefly founded upon *anatomical facts*, such as the system proposed at the beginning of the present century by Cuvier, who divided the whole animal world into four principal types (Vertebrata, Mollusca, Articulata, Radiata); and there are also systems established upon *embryological facts*, such as that of C. Semper, who, as is well known, has quite recently attempted to determine accurately the relationships of animals according to the embryonal primitive kidneys or segmental organs, and to classify the Metazoa phylogenetically upon this exclusively embryological basis *.

The discovery of segmental organs (primitive kidneys) in the embryos of sharks, for which we are indebted to Professor C. Semper, and in part also to the English embryologist F. Balfour, is doubtless so far of great importance to the transformation-theory, that it furnishes a fresh proof of the fact that the Vertebrata and Evertebrata, namely the Vermes, possess in common organs which are homologous from a morphological point of view.

It is, however, questionable whether it is permissible to ascribe to the above-mentioned organs so great an importance, and to found upon them exclusively a classification of the entire animal kingdom. I would ask, is the relationship between the other Vertebrata and the Annelida really greater than between the other Vertebrata and *Amphioxus*, or between this latter and the Ascidia?

Many zoologists believe that they can give science a new direction by selecting according to their judgment one of the embryonal organs, or any phenomenon of the embryonal organism, in order to found upon it a phylogenetic classification, in the hope of being able in this way to establish a natural relationship of the groups of animals. We may readily admit that embryonal characters are of greater value in taxonomy than characters of the fully developed animals derived from anatomy or biology, as in the latter the characters may much more easily suffer change by adaptation and change of function; but we think we may assert with certainty that embryonal characters taken by themselves (even if they relate to the most important organ of the embryo) are far from being sufficient for the sure establishment of the descent of one of the smaller groups of animals, and still more of the whole animal kingdom.

* C. Semper, 'Die Verwandtschafts-Beziehungen der gegliederten Thiere' (Hamburg, 1876), 2 vols.

We think that we must speak in the same way of the system made known by M. A. Giard *. This zealous and otherwise distinguished zoologist, as is well known, took as the basis of his new classification of the animal kingdom the *amnion*, that is the embryonal envelope originating from the ectoderm, and so, according as the embryos possess or are destitute of such an envelope, divided the Metazoa into two great groups (Hymenotoca and Gymnotoca). But that the presence or absence of an embryonal envelope can by no means serve as a proof for or against genealogical relationship, and therefore cannot suffice for the establishment of a grouping of the animal kingdom resting upon natural affinity, will be at once seen by any one who will compare with each other all the different groups of animals, such as the Vertebrata, Tunicata, Arthropoda, Echinodermata, Acanthocephala, Trematoda, Cestoda, Turbellaria, and Nemertina, which Giard united in the group of the Hymenotoca on account of the embryonal envelope observed upon their embryos, although in every other respect many of them stand very far apart. Observation shows us, moreover, that even groups of animals, *e. g.* fishes, amphibia, reptiles, birds, and mammals, which demonstrably belong to one and the same natural stem, differ from each other in this respect, that while some of them (mammals, birds, and reptiles) during their embryonal existence are in possession of an amnion, others, on the contrary (Amphibia and fishes), are quite destitute of any thing of the kind. From this, however, we may evidently conclude that the amnion, or the embryonal envelope, where it is actually present, is to be regarded as originally not an inherited character, but one acquired by adaptation. As such it might originate, under the action of exactly similar conditions in quite divergent animals, even belonging to different stems, and quite independently of each other. It would therefore be very precipitate to conclude at once as to the true relationships of animals, in all cases, from the presence or non-presence of such a character.

We must therefore regard all the different endeavours of systematists to group animals exclusively in accordance with one character, whether morphological, embryological, or biological, external or internal, as mere experiments,—such a grouping or classification of animals can never be the true expression of their natural affinities.

It was an error on the part of L. Agassiz to attempt to group the fishes according to the form and structure of their scales into cycloid, ctenoid, ganoid, and placoid fishes, or

* 'Revue scientifique de la France et de l'étranger' (1876), no. 38.

when the same naturalist referred the *Vorticellæ* to the group Bryozoa merely from their external similarity, without at all taking into account the important differences in their structure and development; and the classifications of the Medusæ attempted by Gegenbaur according to the presence or absence of a velum (*Craspedota* and *Acraspeda*), by Forbes * with exclusive reference to the marginal corpuscles (*Steganophthalmata* and *Gymnophthalmata*), and by Eschscholtz † according to the position of the generative organs (*Phanerocarpæ* and *Cryptocarpæ*) are equally unsatisfactory.

There is consequently no doubt that for the foundation of a truly natural or so-called phylogenetic classification the knowledge and consideration of the individual peculiarities is not sufficient, however important these peculiarities may be, or however early a period of development they may pertain to. The distinguished naturalist Fritz Müller, in his exceedingly valuable little work 'Für Darwin,' has given us a perfectly new systematic grouping of the Crustacea according to one of the earliest embryonal characters, namely the segmentation and the mode of curvature of the embryo within the egg (*Holoschista* and *Hemischista*, *Gasterotropa* and *Nototropa*); but he thereby furnished a proof that the groups proposed by him were any thing rather than natural groups ‡.

Among all properties of animals the biological conditions especially offer the least certainty in their classification, as even animals of admittedly different origin frequently live under exactly similar conditions, and in accordance with this not unfrequently also exhibit the same peculiarities. Thus, for example, the Cetacea and fishes live under exactly similar conditions, and therefore we find, in consequence of adaptation, not only the external form, but also the organs of motion, similarly formed, although, in fact, they are by no means nearly allied to one another. But even among the great marine Mammalia, according to recent investigations, the Sirenia prove to be essentially different from the true whales or Cetacea; and yet both forms of animals are externally so similar as to be confounded together, and they live under exactly the same conditions.

* Forbes, 'Monograph of the British Naked-eyed Medusæ' (London, 1848).

† Eschscholtz, 'System der Acalephen' (Berlin, 1829).

‡ [Leipzig, 1864. English translation under the title of 'Facts and Arguments for Darwin' (London, 1869). The classification here cited is given by Fritz Müller ironically, to show to what results the application of certain authoritative dogmas would lead in the case of the Crustacea.—TRANSL.]

In order to avoid as far as possible these and similar errors all earnest and prominent systematists seek the true character of a group of animals (species, genus, family, &c.) not in its *individual* peculiarities, but in a certain *combination of all characteristic peculiarities*; that is to say, they found the character of the group upon a correctly combined summing-up of all its peculiarities, and, indeed, so that in each individual case the combined sum of the peculiarities always represents a definite animal-form, although the latter must not necessarily be assumed to be so unchangeable as was usual with the systematists of the old school.

Nowadays, therefore, it could not occur to any thorough naturalist or earnest systematist to classify any group of animals in accordance with any exclusively external or internal peculiarity observed either in an embryo, or in a larva, or in fully developed animals, with any one organic or biological condition.

If we now put the question, *how is a correct and really scientific classification of the animal kingdom to be created?* we may be permitted, in connexion with this, to assume as a principle that a classification which, being based upon morphological and embryological facts, also takes sufficiently into account the palæontological and biological data, and carefully follows these facts step by step, must in any case lead with most certainty to the final aim of science. This final aim is, however, nothing else than the knowledge of the law in accordance with which, by means of inheritance and adaptation, animals have originated from each other. If this be correct (as to which, in the light of Darwin's law of development, we cannot doubt for a moment), *then such a classification of the animal kingdom, such a system, can alone be accepted as perfectly natural, objective, and strictly scientific, which is capable of representing, in the form of a genealogical tree, the origin and gradual development of the world of animals.*

Another question is, *whether this ideal goal of our science will some day be really attainable, even after the labour of many generations.* Among the younger zoologists there may perhaps be some who esteem it possible to attain to such a goal; but if we seriously consider the many difficulties of this gigantic task and the insurmountable obstacles presented to it in certain directions, we must perhaps give up the hope that man, who in so many respects is able to govern nature, will really ever be in a position to construct a perfectly objective and truly phylogenetic system of nature. For the present, however, we may be content with the result if we succeed in approaching this final aim as nearly as possible, and in course of time at least in constructing such a system as will represent in part, although not perfectly, the true genealogical tree of the animal kingdom.

We will here at once look somewhat closely into those difficulties and obstacles which may not unfrequently confront the naturalist in his zealous endeavours to determine accurately the relationships of animals, and which readily give rise to errors.

1. Sometimes the difficulty may consist in this, that in the case of organisms with accordant structures one may not unfrequently be inclined to conclude, from the similarity of structure, that they are true blood relations, and further that this affinity must be closer the greater their similarity of structure is found to be. The cautious naturalist, however, will soon perceive that this principle, if very generally applied, easily leads to errors, for *in judging of a true blood-relationship that resemblance only can be of value which is produced originally by inheritance, but not that in which the agreement in structure has merely resulted from adaptation to similar vital conditions.*

The judgment of these circumstances may sometimes appear very difficult, in many cases even impossible. This, then, is a difficulty which may easily lead the zoologist astray by uniting in one and the same branch of the genealogical tree animals which are bound together by no close family tie, and this merely because they show an accordant structure, or because their larvæ or embryos prove to be more or less alike.

In phylogenetic classification therefore the zoologist must above all be able to distinguish well and accurately the homology originating by inheritance, or the so-called *homogeny*, from a similarity produced by adaptation or *homoplasy**.

Observation shows that by the action of similar conditions of life, and therefore merely by adaptation, similar and sometimes almost exactly identical organs may often be developed in animals which belong to perfectly distinct types or natural groups. As examples of this we may cite the chelæ occurring on the legs of crabs, and the palpi and chelicera of scorpions, as well as the pedicellariæ of the Echinodermata, all of which show a wonderful agreement both in structure and function, although no one would venture to assert that they have actually originated from each other by inheritance. In homo-

* Ray Lankester, "On the use of the Term 'Homology,' in Modern Zoology," Ann. & Mag. Nat. Hist., 1870.

plasy or adaptive homology we also find the explanation of the formation of segments which occurs in many Platyelmintha, which therefore, as a simple phenomenon of adaptation, can by no means be equivalent to the metamere-formation of the Annelida. As a homoplasy of the same kind we also regard the resemblance between Rotatoria and Crustacea, which is erroneously interpreted by some authors, as well as that between the bills of birds and the maxillary horny sheaths of the Chelonia, and many others. Many erroneous views in this respect have already been refuted by more accurate investigations.

2. In consequence of Darwin's researches it is generally recognized as the *law of development* in the organic world, *that all organisms, animals as well as plants, are in a state of constant, although very slow, change and progressive development, so that, in general, the effort to attain greater perfection is predominant in the organic world.* From this constantly advancing progressive movement of phylogenesis many have erroneously concluded that all the simpler organisms living at the present day are only the representatives of similar animals which have continued in existence from an earlier period, and that consequently those natural groups to which they belong have never been at a higher stage of organization than that upon which they now stand.

In accordance with this principle many were at first of opinion that the whole animal kingdom, as well as its larger and smaller groups, might be quite simply embraced in several ascending series, just as these, in consequence of constant and unceasing advance towards perfection, had gradually become developed from the lowest to the highest stage of animal organization. It was soon found to be impossible, however, to establish the true genealogical tree of the animal kingdom upon this principle without falling into faults and errors. For Darwin's law of development, which in its final results is certainly *progressive, by no means excludes a retrograde movement or retrogression in certain stages of development,* as life presents not only progressive but also retrograde phenomena of movement, and absolute rest or unchangeability (*Stabilismus*) is an impossibility in Nature as in social life. In accordance with this law, by the action of unfavourable conditions of existence, and by means of natural selection, perfectly organized higher organisms may originate much simpler forms, which are, so to speak, degenerated by retrogression, although for this very reason better fitted for and corresponding to the new conditions of existence.

Of late the *parasitic animals* have been regarded as such animal forms, as well as those which live under ground, in mud, in dark caverns, and at great depths in the sea, or which, firmly adhering to other bodies, are incapable of any locomotion. We may refer here only to the Trematoda and Cestoda among the Platyelmintha, which evidently are nothing but the direct descendants of Turbellaria once leading a free existence, but gradually retrograded in consequence of a parasitic mode of life. The Cirripedia and Rhizocephala among Crustaceans, and the Linguatulidæ among the Arachnida, are nowadays justly regarded as such animal forms produced by retrograde metamorphosis, as also the Bryozoa, Brachiopoda, &c.

It may, however, not always be easy to recognize with certainty the cases of retrograde phylogenesis, or degeneration, and probably many forms which at present are ascribed to retrograde metamorphosis may in course of time prove to be progressive animal forms.

As in all other things, so also in science, man is inclined to overstep the bounds of sober reason, and to assume or assert *à priori* more than what facts directly prove. This applies so much to *the theory of retrogression or degeneration*, so widely diffused at the present day, that a natural philosopher has even ventured to set up the proposition that all animal forms are direct descendants of man, gradually degenerated by retrogressive metamorphosis!

Another view, which I believe to be erroneous, is also entertained by some *savants*, namely, *the opinion that the formation of body-segments (metameres), or the repetition of similar parts of the body, always leads towards the perfection of the organism.* In accordance with this assumption many naturalists are inclined to derive the unsegmented animal-forms, or those destitute of metameres, from supposititiously more perfect and allied animals, in which the body was once composed of numerous segments or metameres, and therefore originally segmented. Prof. Semper, of Würzburg, as is well known, has lately promulgated a similar opinion*, namely, that the Mollusca are to be regarded as the direct descendants of the Annelida, and consequently that the unsegmented Molluscan form has gradually been developed by retrograde metamorphosis from the Annelidan form. While it is possible, or even probable, that in many cases the formation of metameres, or the frequent repetition of equivalent parts, may lead towards perfection, observation often seems to prove the contrary. Thus, for example, among the Mollusca, we find generally in the Cephalopoda and Gasteropoda not the smallest trace of metamere formation (with the exception of the ex-

* *Op. cit. suprà*, p. 315, note.

tremely anomalous form of the Placophora or Chitonacea, whose segmentation, moreover, is only external, imperfect, and apparent), and yet these stand upon an indubitably higher stage of organization than the Annelida composed of innumerable metameres. No one certainly will nowadays regard the Myriopoda as higher or more perfect animals than the Insecta or Arachnida, although in the latter it is the amalgamation of metameres that leads to greater concentration of the organization and individual perfection. The same is proved by the Vertebrata, the lower and less perfect forms of which are in general characterized by a greater number of metameres than the higher Vertebrata, the Amniota, which have been gradually developed from them by means of progressive phylogenesis.

In organic nature, as in human society, the law seems generally to prevail that, by the fusion of similarly constructed equivalent parts into larger complexes, an individually higher potentiality and perfection of the general organism always results. This is most strikingly shown to us in the formation of the head out of a certain number of metameres by the fusion of the anterior segments in the Arthropoda and Vertebrata; while, on the other hand, a frequent repetition of the more or less independent homologous parts or organs seems usually, in most organisms, to indicate an organic inferiority.

For these reasons many, especially among the American zoologists (A. Agassiz among others), justly regard the greater concentration of the organism, the so-called "*cephalization*," as the indication of a higher potentialization of the organization, a higher degree of perfection; and "*metamerization*," on the contrary, generally as the character of greater inferiority in the organism; so that the cephalized organisms, as it were, represent centralized states, and the metamerized mere federations.

All these considerations appear to be important and significant when we have to do with determining the natural position of an organism on the genealogical tree, and to state exactly to what branch or twig it belongs, in accordance with its affinities and derivations, and at which end (the upper or the lower) of the twig it is to be placed.

We see this best in the case of the Tunicata. The most esteemed and authoritative zoologists of the present day (Gegenbaur, Huxley, Ray Lankester, Giard, &c.) regard the near affinity of these animals with the lowest Vertebrata, especially with *Amphioxus*, as completely demonstrated, and this not alone because as regards their structure and development the above mentioned animals are surprisingly similar, and agree in most of their characters, but, above all, for the special and important reason that there seems to be evidence that the chorda which occurs in nearly all Ascidia in the larval period (with the sole exception of the Molgulidæ) can by no means be regarded as an organ acquired by adaptation during the larval period, but as one which they have obtained originally by inheritance from their formerly more perfectly organized ancestors. We may therefore, from the transitory presence of the chorda, and its, in most cases, complete retrogression at a later period, draw the correct conclusion that the Tunicata were not produced by progressive phylogenesis, but that they must have originated by retrogression or degeneration from other more highly organized ancestors, similar, but provided with a fully developed chorda.

If we now suppose the case that of the known Tunicata the *Appendiculariæ* and all those numerous Ascidia which possess a chorda in the larval period had by chance disappeared without leaving any traces, we may ask, what proof should we then have of the retrograde metamorphosis of the Tunicata? It might then easily happen that we should place them at the topmost stage of some lower but progressive series of animals, and therefore classify them incorrectly in the system.

It will be seen from this that for correct classification caution and sober reason are above all necessary, especially in those cases where we have to do with the accurate determination of the relationships of an isolated group, with the development and other essential peculiarities of which we are only imperfectly acquainted.

When we take all this into consideration it appears clearly that *side by side with progressive phylogenetic series there are also retrogressive series and groups, which, in spite of frequently very divergent structure, may nevertheless not unfrequently be very nearly allied.*

Darwin's law of development justifies the assumption that among the many partly progressive, partly retrogressive series there must certainly exist one progressive developmental series, which commences below with a perfectly simple plastid and terminates above in man; but to decide which of the numerous branches and twigs of the genealogical tree of animals are truly progressive, or which of them owe their existence to a retrogressive phylogenesis, can only become possible in course of time, and then with any certainty, or at any rate with probability, only upon the foundation of embryological and morphological investigations. So long, however, as we have no indubitable grounds or facts which directly indicate the retrogression or degeneration of a given animal-form or group, we shall proceed most securely in judging of its derivation if we for the time assume it to have been progressive.

Nevertheless there are animals with regard to which we may assume, if not with certainty at least with much probability, that they have originated by retrograde development from other more perfect animals. Thus, among others, it seems very probable that the Dicyemidæ, which E. van Beneden regards as an independent progressive animal-form standing between Protozoa and Metazoa, and refers to the group Mesozoa, which he has established, are really only forms of some Platyelminth, degenerate in consequence of a parasitic mode of life; just as the Myzostoma are Chætopod worms degenerated by retrograde metamorphosis. It is, moreover, probable, although not certain, that among the Protozoa forms occur which possibly owe their existence to a retrograde metamorphosis and have originated from Metazoa. Nay, the possibility does not seem to be excluded that even the Polyps and Corals belong to the retrogressive animal-forms, and perhaps are nothing else than the peculiarly modified and degenerated descendants of some originally free-swimming bilateral form of worm. Even in the great group of the Vertebrata it is a highly interesting question *whether* Amphioxus *and the Cyclostomi are not the descendants of some more highly organized craniate Protovertebrate, constructed after the type of the Monorhina, which has become in course of time entirely extinct*, and in which both the jaws and the paired limbs were still wanting.

3. Besides the difficulties here mentioned which come in our way in the classification of the animal kingdon, but which seem to be superable sooner or later by further investigation and unwearied labour, we must consider one obstacle, the power of which the human mind will never be able completely to overcome.

Thus, for a truly genealogical and phylogenetic classification of the animal kingdom we need not only an accurate knowledge of the existing forms, but also of those which have long since been extinct, and, further, a comparison of these forms with each other, for palæontological facts, as is well known, are of no less value than the knowledge of the embryological and morphological characters of living animals.

According to Darwin's developmental law, we may conclude that very numerous *transitional forms* between the different groups of animals must formerly have existed; this is the necessary condition, the natural result of the theory of evolution. Matters are quite different, however, when we consider existing nature. We see that existing animals are all separated into larger or smaller groups, more or less removed from each other. The individual members of these groups frequently stand in very close relationship to one another, but the groups themselves are generally separated by smaller or larger intervals or gaps, and these gaps are now usually not occupied by intermediate forms. Every isolated group in the system, many families, orders, and classes furnish plenty of examples of what has just been said.

It would be a great mistake if any one were to conclude at once, from the total absence of intermediate forms, that such had never existed in nature. As experience shows, it is only in very rare cases and under favourable conditions that the fossil forms remain quite unaltered, leaving out of consideration the fact that a great number of them, such as the Cœlenterata, Tunicata, and Protovertebrata, as well as the greater part of the Vermes, owing to their softer texture, could not, even under the most favourable circumstances, leave any trace behind them.

What great value attaches to the knowledge of palæontological facts, and how important it is for the determination of the phylogenetic relationships between the different groups, as well as for a correct classification, is best proved by the most recent position of our system. Thus the character or definition of the class of Birds appears something quite different, if we take into consideration exclusively the existing forms, or if we include the extinct *Archæopteryx* and the fossil *Odontornithes* (toothed birds), lately discovered by Prof. Marsh in North America, such as *Hesperornis regalis* and *Ichthyornis dispar*. Not only in this class, however, but in nearly every more or less isolated group, forms occur, the natural position of which in the system can only be correctly determined by comparison with the known palæontological types. If we consider thegreat number of extinct forms the traces of which are still unknown to us, we must regard the establishment of a complete genealogical and phylogenetic system as still impossible, considering the imperfection of our present palæontological knowledge. Finally, if we think of those delicate and soft animal forms whose traces are entirely lost, and which therefore will for ever remain unknown to the naturalist, it becomes more than probable *that we shall really never be in a position to establish and completely construct an absolutely perfect genealogical tree of the whole animal kingdom.*

For the present, however, we must content ourselves with the best attainable, and we may be satisfied with the result of our labour if, supported on the morphological and embryological facts already collected and ascertained, and considering the known palæontological forms, we endeavour with our full knowledge and conscientiously, by a systematic grouping of the animal kingdom, to express, to the best of our power, the relations existing between the different animals, as well as the natural position of the groups and their individual members.

Now that we have discussed in detail the general principles of classification, as well as the precautions necessary for a natural grouping of animals, I may be permitted, as a small contribution towards the construction of a phylogenetic system, to expound my views as to the relationships of the different groups, although only tentatively, in the form of a genealogical tree (see p. 334). In the grouping of the different stems, as well as in their relations to one another, this agrees in many respects with others, but nevertheless, as regards certain ramifications and groups of the genealogical tree, it differs, not unessentially, from other similar attempts. The following remarks may serve to explain and elucidate our subject.

First of all I must notice particularly that, although the denominations "Protozoa" and "Metazoa" are almost universally employed in modern zoology for the two principal groups of the animal kingdom, I think it would be better to call the former "Protoplastica," as a word which expresses more accurately and better the nature of these lowest animals; and the latter "Blastodermica." In these latter the body never consists of one or more homogeneous protoplasmic cells, but is always composed of heterogeneous cells and tissues, which tissues are originally produced from two different blastodermic cell- or germ-layers, namely, from the primitive *ectoderm* and *entoderm*.

The animals which are developed with such a blastoderm (Blastodermica) divide, from a phylogenetic point of view, into two main branches.

The smaller main branch is represented by those blastodermic animals which, remaining at a low stage of development, possess only a simple primitive nutritive cavity, formed by the ectoderm alone, without any trace of a cœloma. These lower Metazoa (Blastodermica), which are nourished by a primitive nutritive cavity (*archenteron*), we therefore name "Archentera."

To the Archentera there belong, according to our views, as separate ramifications or phyla, the *Porifera* (Sponges) and the *Cœlenterata.*

With regard to the Porifera or Sponges, I by no means share in the opinion of those naturalists who regard these animals somewhat as aborted or degenerated Anthozoa, and who, partly for this reason and partly on account of the similarity in structure and development, refer them to the stem of the Cœlenterata. It is possible that they only form a transition between the Protozoa and Metazoa, and perhaps are nothing else than colonies or cell-stocks composed of different kinds of cell-individuals, so that a part of the cells have the duty of alimentation and reproduction, while the other cells perform the functions of respiration and movement. It is well known that Clark, referring to the presence of the peculiar collared cells or flagellate cells which have hitherto been found in no other blastodermic animals, has brought the Sponges into direct connexion with the Flagellata, described by him under the names of *Salpingœca* and *Codosiga* (= *Cylicomastiges*, Bütschli), and explained them as resembling the colonies composed of Flagellata. This view may certainly be very well brought into agreement with the still free-swimming larvæ of the Sponges, but it most decidedly contradicts the further developmental characters of the Sponges, especially taking into consideration the recently acquired embryological facts, according to which the Porifera differ in no small degree from the other Metazoa both in the formation and in the function of the germ-lamellæ. If this be really the case, we must regard them logically as a group of animals equivalent to the Metazoa, but differing from them.

So long, however, as the developmental history of these animals is not accurately and thoroughly known, I regard it as more logical to refer them for the present to the Metazoa, and to regard them as a special type or ramification of the Archenterate main-branch, diverging from the Cœlenterata.

Another, far stronger, main branch of the blastodermic animals combines all those animal-stems which, with the exception of some Platyelmintha (Turbellaria, Trematoda, and Cestoda), are all provided with a secondary alimentary canal (*metenteron*), composed of two layers, namely, the entodermal layer and the inner mesodermal lamina (*splanchnopleura*), and enclosed by a cœloma. As the cœloma generally, as is well known, originates by constriction from the archenteron, and indeed from the parenteric processes or diverticula of the latter, we characterize all those blastodermic animals or Metazoa which possess a perfect secondary alimentary canal, modified in the way just mentioned, with the name of *Metentera*.

To the great main-branch of the Metentera belong, above all, in our opinion, the vermiform animals or Helminthozoa. According to all extant investigations, these animals form one of the oldest of the great stems or phyla of the whole genealogical tree, most important from a phylogenetic point of view, and most interesting anatomically and embryologically. The group Helminthozoa embraces very many different forms, which, as regards both their structure and their mode of development, differ so much from each other that it can hardly be regarded as too bold an assertion to say that, in the whole animal kingdom, there is hardly another stem that would embrace such different and sometimes widely divergent modifications or classes. For this reason, also, it seems scarcely permissible to regard the Vermes as forming an equally unitary animal-type, as, for example, the Arthropoda, Echinodermata, Cœlenterata, and other great groups. Thus, among other things, the Platyelmintha (with the sole exception of the Nemertina) are distinguished not only by greater simplicity of organization, but also essentially by the absence of a true cœloma, from all other Vermes, and even from all Metentera. Nay, from this last-mentioned negative character (the absence of a cœloma) they might quite logically be regarded as a special group of the Archentera. We must not forget, however, that the Platyelmintha which are destitute of a cœloma (Turbellaria, Trematoda, and Cestoda) are, on the other hand, nearly related to the Nemertina, and through these to the other groups of the same stem, all of which are furnished with a cœloma; also that the other groups of the Vermes deviate from one another in many respects, and sometimes considerably, especially when we take into account the segmentation of the ovum and the mode of formation of the cœloma. Chiefly for this reason we hold it necessary for the present still to regard the Platyelmintha as united with the other groups of Vermes in the common stem of the Helminthozoa, although, by many naturalists, attempts have already been made to divide this stem into several subordinate stems or subphyla. But if we consider how imperfect the knowledge still is that we possess as to the structure and development of the Vermes, we must regard all such attempts at the present day as premature.

The results of the numerous investigations hitherto made seem only to prove one thing, namely, that the stem Vermes is perhaps very well divisible into two or several divergent branches—the group of the *Scolecida* (Platyelmintha with the exception of the Nemertina) and the group of the *Annelida*. Of these latter, however, the *Polychæta* differ essentially in their mode of development from the *Oligochæta*, and, moreover, as is well known, there are many other forms, such as the *Nematoda*, *Acanthocephala*, *Gephyrea*, *Chætopoda*, *Enteropneusta*, and *Rotatoria*, which differ not inconsiderably, in many respects, not only from the above-mentioned Annelida and Scolecida, but also from one another.

From the consideration of all these facts, from the standpoint of phylogenesis, in accordance with the present state of science, only one thing can be accepted as established, namely, *that the Helminthozoa form on the genealogical tree of the animal kingdom, a knot, which is at present not quite untiable, from which probably all the other higher stems have branched off* (see the Table, p. 334); and, consequently, there is no doubt that the main stem of the Helminthozoa was of the greatest importance in the origin and descendence of the higher types.

From the results of recent embryological investigations it is sufficiently clear that the embryos, as well as the free-swimming ciliated larvæ, of different Vermes more or less resemble the larvæ of the Echinodermata, Bryozoa, Brachiopoda, many Mollusca, and the Provertebrata (Tunicata and Leptocardii). From the remarkable similarity of the conditions of development of these animals it is further to be assumed that these might all have originated by the process of natural selection from one or more simple, vermiform, primitive forms. Nevertheless we must freely admit that the known facts of embryology, as well as all the hypotheses built upon these facts, by no means suffice for the final decision of the question, From what special primitive form have the Mollusca, Bryozoa, and Brachiopoda, the Arthropoda and the Provertebrata been phylogenetically developed? Both in amount and in importance the facts at present known are only capable of proving this much: that the great stem of the Helminthozoa very probably forms the starting-point for the higher animal-stems of the Echinodermata, Arthropoda, Malacozoa, and Chordovertebrata.

Further, as regards the opinion of Prof. Semper and other zoologists, according to which the Annelida are specially adopted as the ancestors of the Vertebrata, I may here be permitted only to remark that the facts cited for the establishment of this opinion (the segmental organs or primitive kidneys) do not, in my estimation, suffice to demonstra e indubitably that the Annelida are in reality more nearly allied to the Vertebrata than these latter to *Amphioxus* and the Tunicata. Nay, it even seems very probable that the resemblance founded upon the segmental organs *does not owe its existence originally to heredity*, but that it has originated only in consequence of adaptation to similar conditions of existence, and consequently is to be referred to a so-called *homoplasy*, which, as has already been explained in detail, is not sufficient for the demonstration of a true blood-relationship. In my opinion, that other hypothesis is much more acceptable, according to which both the Annelida and the Provertebrata have originally been produced from worms whose body as yet exhibited no segmentation at all, such as we may still see among the Turbellaria, Nemertina, Chætognatha, Enteropneusta, and Nematoda.

With regard to the Bryozoa and Brachiopoda, my tendency is towards the opinion *that these animals belong to the great stem of the Malacozoa.* It appears exceedingly probable that they branched off very early from the true Mollusca, as is sufficiently proved by a careful comparison of their structure and conditions of development, and especially the similarity of their larvæ (modified trochospheres). This view finds further support in the interesting form *Rhabdopleura*, (a divergent form of the Phylactolæmata), which becomes of the more importance because, in its external form and internal structure, it is very similar not only to the Brachiopoda, but also (according to Ray Lankester's investigations) to the embryos of a Lamellibranchiate, namely *Pisidium.* All this may serve as evidence that the Bryozoa, as also the Brachiopoda, have originated with the true Mollusca from one and the same main stem, and, indeed, very probably by their having, at a very early geological period, gradually adapted themselves to a sedentary mode of life, differing from that of the remaining progressive Malacozoa.

Upon these facts and considerations we have thought that we could best represent the true relationships of the Bryozoa and Brachiopoda to each other and to the true Mollusca by dividing the main stem of the Malacozoa into two branches or subphyla, of which the larger branch embraces the so-called Mollusca, *i. e.* all the more or less *progressive* forms of this stem (Lamellibranchiata, Scaphopoda, Placophora, Gastropoda, Pteropoda, and Cephalopoda, as distinct classes), while the other branch, namely the subphylum of the Molluscoidea, includes the Brachiopoda and Bryozoa, originating by means of retrogressive phylogenesis.

With regard to the groups belonging to the stem of the Arthropoda, we must remark that, as is well known, the number of Arthropoda breathing by tracheæ has lately, since the structure and development of *Peripatus* have been more accurately known, been increased by a new class, namely that of the Protracheata (of Balfour and others). Since Moseley succeeded in proving that these animals, which for a long time were referred to the Vermes under the name of *Onychophora*, really respire by tracheæ, and were also distinguished from the other Arthropoda by the possession of quite divergent, primitively constructed, and foot-like buccal organs *, I regard it as perfectly right to unite this small but interesting group, after the example of recent naturalists, with the stem of the Arthropoda as a separate branch of the Tracheata.

In like manner I have regarded it as more judicious and more in accordance with nature to establish in the class Crustacea, besides the chief groups hitherto adopted (Thoracostraca, Arthrostraca, and Entomostraca), a fourth group, namely that of the Palæostraca. This section of the Crustacea, which includes the Trilobita and the Xiphosura, as well as the fossil Merostomata first described by H. Woodward, is distinguished from all others by the fact that the mouth-organs of the forms belonging to it are very different from those of the other Crustacea, and either foot-like or rudimentary, or sometimes even entirely wanting (Trilobita).

Finally, as regards the *Chordo-Vertebrata*, I find myself led in some points to adopt views somewhat diverging from those of other naturalists. Thus I agree perfectly with Balfour, Ray Lankester, &c., that we must unite the Urochorda (Tunicata) as well as the Cephalochorda (Leptocardii) with the stem of the Vertebrata; but with respect to the Cyclostomi or Monorhina I by no means share the opinion of those *savants*. The Cyclostomi are in fact distinguished by a great number of partly positive, partly negative, characters of importance, which never occur elsewhere in other fishes (Selachii, Ganoidei, Dipnoi, and Teleostei), or, indeed, in any true Vertebrata even during the embryonal period; and by these peculiarities they evidently, on the other hand, nearly approach the Leptocardii and Tunicata. These characters are:—

a. The absence of the mandible.
b. The absence of paired extremities.
c. The absence of the *nervus sympathicus*.
d. The originally simple and unpaired nasal cavity (olfactory cavity) with a simple external dorsal olfactory aperture.

* Phil. Trans. vol. clxiv. (1874).

e. The composition of all the nerves of exclusively white elements.

f. The direct course of the *nervi optici* to the two eyes without any crossing.

g. A remarkably large and wide stomadæum, or the remarkable size of the anterior portion of the alimentary canal representing the stomadæum.

h. The occurrence of a hypopharyngeal groove, always developed at least during the larval period.

i. The smoothness and softness of the integuments, as well as the absence of any formation of scales.

k. Absence of the lateral organs which are developed elsewhere in all fishes and Amphibia (in the latter in the larval period).

If the Cyclostomi be compared with *Amphioxus* and the Tunicata, we find, further, that of all these the Cyclostomi alone are possessed of a primitive cartilaginous skull, in which a præchordal part is already developed. If, however, we examine this Cyclostome skull more closely, we arrive at once at the conviction that, as regards its external form and internal structure, it presents essential differences from the cartilaginous skull of fishes (Selachii, Dipnoi, Ganoidei).

The blood is red, like that of other fishes, but the blood-corpuscles are of a circular and not of an elliptical form.

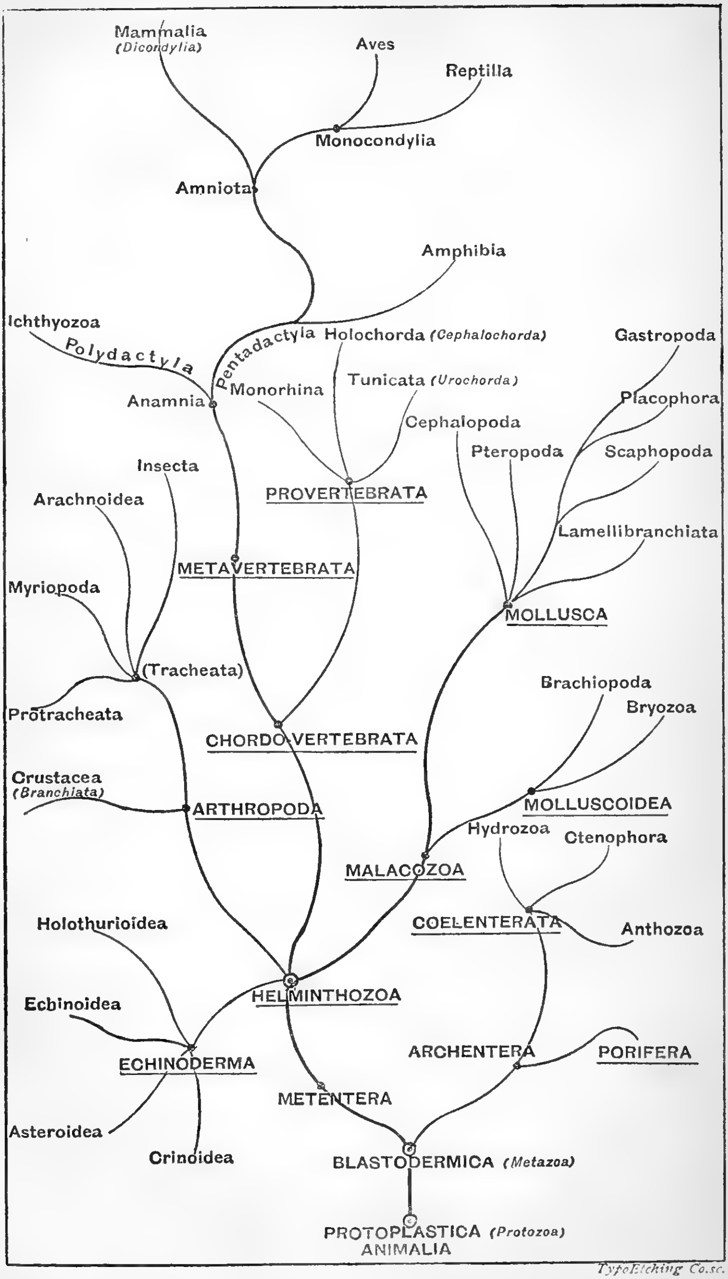
The segmentation of the ovum, as shown by recent investigations, is not regular, as in *Amphioxus* and the Tunicata, but irregular and amphiblastic (as in *Acipenser* and the Batrachia). But if we consider that the mode of segmentation may sometimes be quite different even in nearly allied animals, and that, moreover, the conditions of existence of the animal may exert a great influence, if not directly, yet indirectly, upon the process of segmentation, we must regard the different mode of segmentation as by no means a safe criterion in judging of the relationships of the Cyclostomi. On the other hand, it seems to us to be of much greater importance that the earliest larval form of *Petromyzon* is very like *Amphioxus,* and then subsequently becomes transformed first into the *Ammocœtes*-form, and finally into the definitive form.

If, then, we take all these peculiarities into consideration, and weigh them all carefully, it appears clearly that the number of bonds which unite the Cyclostomi with *Amphioxus* and the Tunicata is greater than the number of characters which those animals have in common with the Selachii and the other fishes.

I think, therefore, that the relationships between the different classes of the Chordo-Vertebrata may be expressed by a more natural grouping, if I divide their main stem into two divergent branches or subphyla, one of which, *the subphylum of the Provertebrata*, or *Primitive Vertebrata*, includes the more or less reduced or retrogressive forms of simpler structure, furnished with a wide stomadæum, a hypopharyngeal groove, and an unpaired median olfactory organ, but destitute of a mandible and of paired limbs, as well as of a *nervus sympathicus* and of true lateral organs, to which belong, as distinct classes, the Tunicata, Leptocardii, and Monorhina. The other, larger branch, *the subphylum of the Metavertebrata*, or true Vertebrates, would then embrace the true fishes or Ichthyozoa (Selachii, Ganoidei, Dipnoi, and Teleostei), originating by progressive phylogenesis the Amphibia, Reptilia, Birds, and Mammalia, all of which are furnished with mandibles, paired extremities, paired nasal cavities, and a *nervus sympathicus* (see Table, p. 334).

As regards the forms of the *Provertebrata* living in the present geological period, *it appears very probable that they are the descendants of the more perfect free primitive Vertebrates which existed in Palæozoic times, even before the first appearance of the Selachii, of which, however, a great part has gradually died out and disappeared entirely in consequence of the occurrence of unfavourable conditions of existence in course of time.*

And if we consider, in conclusion, that the still existing forms of the *Provertebrata* are for the most part characterized by a semi-parasitic or sedentary mode of life, it may be assumed with some probability that they are indebted for their preservation to this their peculiar mode of life. Thus, while some of their formerly free-living ancestors had the good fortune to become transformed by natural selection in the way of progressive phylogenesis into *Metavertebrata*, or true Vertebrates, and others, on the contrary, in course of time have gradually died out, the rest were able, in consequence of retrogressive metamorphosis, to maintain their existence, although with a reduced structure of body, under the allotted conditions of existence, uninjured to the present day, in the form of Tunicata, Leptocardii, or Monorhina.



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XXXVI.—*Description of a new Species of* Ptycholepis *from the Lias of Lyme Regis.* By JAMES W. DAVIS, F.G.S. &c.

[Plate X.]

Genus PTYCHOLEPIS, Agassiz.

Scales thick, elongated, plicated transversely on the base, and deeply furrowed longitudinally; under surface smooth and devoid of rib; pectoral fins pointed; dorsal fin opposite the ventral fin; anal fins remote. (*Egerton.*)

Ptycholepis gracilis, sp. nov.

A well-preserved specimen of *Ptycholepis* recently came into my possession, which differs in several respects from the species of this genus which have been described by Prof. Agassiz and Sir Philip Egerton. Its form is more attenuated than that of either of the previously figured species.

The first representative of the genus, *Ptycholepis bollensis**, Agassiz, from the Lias at Whitby, was a tolerably large specimen about 10·5 inches in length, of which length the head occupies more than one fourth. Sir Philip Egerton described two species, *P. minor* † and *P. curtus* ‡; the former, from the Lias of Barrow-on-Soar, is a small and elegant fish, now in the Enniskillen-Egerton collection at the Natural-History Museum, South Kensington. *Ptyocholepis curtus* is a much shorter and thicker fish; it is 4·75 inches in length, the head being 1·75 inch, or more than one third the entire length of the fish. The depth of the body at the dorsal fin is 1·7 inch. The specimen now before me is 7 inches in length from the snout to the termination of the tail; of this length the head occupies 1·5 inch, and the depth of the body at the dorsal fin is 1·5 inch. In proportion to the size of the whole fish the head is much smaller than in any of the species before mentioned, and the form of the body is slender and graceful as compared with either *P. bollensis*, Ag., or *P. curtus*, Eg. The anterior portion of the dorsal outline of the specimen is slightly broken, the ventral and caudal margins are intact, and the lateral surface of the body and head is beautifully preserved.

The head is small, more or less triangular, with a bluntly-rounded snout; the posterior outline of the operculum is

* 'Poissons Fossiles,' vol. ii. part 2, p. 108, pl. lix. *b*, figs. 1-3 (1833-43).
† 'Memoirs of the Geological Survey,' dec. vi. pl. vii.
‡ *Ibid.* dec. viii. pl. viii. (1853).

convex; the mouth is large, apparently extending far towards the anterior extremity of the operculum; the snout projects a short distance beyond the mouth; the orbit is well developed, occupying an area one fifth the length of the head and about its own diameter distant from the end of the snout. The bones of the head are well preserved, and are ornamented with the enamelled ridges characteristic of the genus. The operculum—unlike that of *P. bollensis*, which is smooth, or *P. curtus*, which is anteriorly ornamented by widely separated ridges, whilst on the posterior portion they are nearly obsolete—in this specimen is deeply channelled, the shining ridges standing in high relief over the whole surface, but without any apparently definite arrangement. Along the inner or basal margin of the operculum there is a narrow strip, separated by a deep groove, which is perfectly smooth. The suboperculum is comparatively small; it is similarly decorated and possesses a smooth strip along the margin next the operculum. The bones of the cranium, as well as those of the jaws, are ornamented with a series of more or less parallel ridges, which anteriorly bend with a sinuous curvature so as to encircle the nasal extremity.

The *scales* on the body are larger anteriorly than those nearer the tail; they are arranged in symmetrical parallel rows, each about ·1 inch in length and extending more or less diagonally from the dorsal towards the ventral surface. The scales of the dorsal part of the body are wider than those of the ventral. The enlarged figure (Pl. X. fig. 1 *a*) represents a scale midway across the body and ·5 inch behind the operculum; fig. 1 *c* is taken from the ventral surface at ·5 inch behind the pectoral fin, and 1 *b* is from the surface near the tail. The posterior margin of all the scales is deeply serrated; the number of serrations varies with the width of the scales, and corresponding to them are depressions of the surface or grooves, deepest at the anterior margin and extending towards, but rarely attaining, the posterior one. The base of each scale has a number of transverse imbrications, delicately marked and only distinguishable when highly magnified.

The *dorsal fin* is indicated by a faint impression of some of the fin-rays. It appears to be situated slightly in advance of the ventral fins, but not so much so as in *Ptycholepis curtus*, Egert. The *pectoral fins* are situated immediately behind the head; they are well developed, nearly an inch in length, consisting of about twenty rays. The rays are grooved near the base, but afterwards dichotomizing towards the margin; the transverse articulations are clearly discernible at about half an inch from the base of the fin, and may be distinguished to the outer extremity of the rays. A series of minute fulcral scales extends along the margin of the anterior ray of the fin. The *ventral fin* is smaller than the pectoral and is equidistant between the pectoral fin and the tail; in this specimen the fin may not be quite perfect; it is ·7 inch in length. The basal part of the rays is grooved longitudinally, as in the pectoral fin, and their extremities are divided into two or more parts. The *anal fin* is not well defined. The *tail* is supported by a base ·7 inch across; it is forked, the distal extremities of the two lobes being 2 inches apart. The base of each lobe is somewhat hidden by a covering of iron pyrites; the extremities are composed of fine rays divided and subdivided from those nearer the base; each is composed of numerous small joints attached by transverse articulations. A number of triangular scales thickly coated with black enamel encircle the dorsal aspect of the base of the tail and extend along the margin of the upper lobe of the tail in an oblique imbricating series, decreasing in size as they approach the extremity. The lower lobe is devoid of fulcra. The vertebral column is extended towards or partially into the upper lobe of the tail. The lower lobe, though the rays are finer, is considerably larger than the upper one.

This species is characterized by its slim and graceful form and the small size of the head in proportion to that of the body. It may also be distinguished by the ornamentation of the head-plates and scales, the difference between the latter and the corresponding scales of the species described by Prof. Agassiz and Sir Philip Egerton being sufficiently characteristic. Sir Philip Egerton, in a supplement to the eighth decade of the 'Memoirs of the Geological Survey,' gives some details of a second specimen of *Ptycholepis curtus* found at Lyme Regis; the length of the fish is $5\frac{1}{2}$ inches and that of the head two inches, showing a similar disproportion as compared with the example now described. The ventral fins are placed nearer to the pectoral than the anal fins in *P. curtus*; whereas in this species the anal fin cannot be more than half as far from the ventral as the latter from the pectoral.

I propose to designate this species *Ptycholepis gracilis*.

Locality. Lias, Lyme Regis.

EXPLANATION OF PLATE X.

Fig. 1. *Ptycholepis gracilis,* Davis. Natural size.
Fig. 1 *a*. Scale midway across the body, about half an inch behind the operculum. ×15.
Fig. 1 *b*. Scale near the caudal extremity. ×15.
Fig. 1 *c*. Scale from the ventral surface. ×15.

XXXVII.—*On three new Species of Monticuliporoid Corals.* By ARTHUR H. FOORD, F.G.S., late Assistant Palæontologist to the Geological and Natural History Survey of Canada.

[Plate XII.]

1. *Monotrypa macropora*, Foord. (Pl. XII. figs. 1–1 *d.*)

Corallum discoid, concavo-convex, with expanding and gradually tapering margins; attached by the base to some foreign body, such as a shell or trilobite. Base covered with a thin and concentrically wrinkled epitheca. Cells opening upon the upper surface of the corallum. Calicinal surface almost smooth, with very slightly raised areas about 5 millimetres apart, occupied by groups of cells a little larger than the average. Of the larger cells about one to one and a half fill the space of 1 millimetre; of the smaller about two are comprised within the same limits. The largest specimen known to the writer measures about 7 centimetres in its greatest diameter and about 25 millimetres in thickness, from the centre of the surface to the base, measured vertically.

Microscopic characters.—In sections taken as near to the surface as possible the corallites are observed to be polygonal, mostly six-sided, with comparatively thin but remarkably clearly outlined walls, the original divisions of which may be faintly discerned under a moderately high power. Clusters of the larger cells are seen grouped together amongst those of the average size, while at rare intervals a few much smaller ones are intercalated with the former (fig. 1 *b*); but these are not of the nature of interstitial tubes, their tabulation not differing in any respect from that of the other corallites. Sections cut longitudinally to the axis of the corallites show that these are furnished with complete horizontal or slightly curved and very delicate tabulæ, which vary from about one half to two tube-diameters apart.

This species may be readily distinguished from the only one of the genus hitherto described from British rocks, viz. *Monotrypa crenulata*, Nicholson *, by its discoidal habit of growth, the large size of its corallites, its more abundant tabulæ, the total absence of crenulations in the tube-walls, and lastly by the presence of small angular corallites.

The writer is indebted to the kindness of Mr. George Maw,

* Ann. & Mag. Nat. Hist. ser. 5, vol. xiii. p. 124, fig. 2 (1884).

F.G.S., for a fine example of this species, from which the section figured on Pl. XII. fig. 1 *b* was prepared. The species appears to be not rare in the Buildwas beds (Wenlock shales), where they crop out on the east bank of the Severn near Buildwas Abbey. It is associated in these beds with a rich Brachiopodous fauna, which has been worked out by Messrs. Davidson and Maw *.

The two following species are contained in the collections of the British Museum (South Kensington), and the author has obtained Dr. Woodward's kind permission to describe them.

2. *Amplexopora* † *microstoma*, Foord.

Corallum lobato-palmate, with a tendency to become ramose in some places. Surface with irregular swellings. Corallites prismatic, extremely slender, nearly straight in the axial region, but bending slightly towards the surface. No monticules are present, but the surface shows under a hand-lens small clusters of cells somewhat larger than the average. Of these about three occupy the space of 1 millimetre, and about five of the smaller ones, so that the latter do not exceed $\frac{1}{125}$ inch in diameter. In rough fractures the walls of the cells are seen quite distinctly to be minutely crenulate, a character which occurs in so many species of the Monticuliporidæ ‡ that its value for purposes of classification appears very questionable.

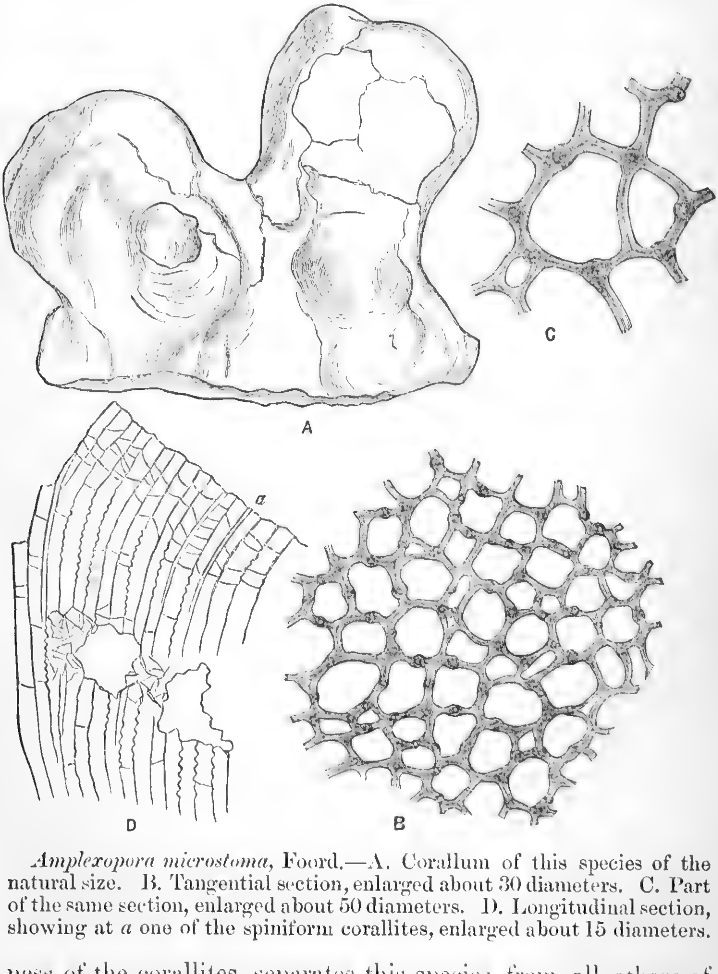
Microscopic characters.—Tangential sections show that the corallites are thin-walled, polygonal in outline, and very variable in size. The spiniform corallites are numerous and are observed at the angles of junction of the cell-walls, and frequently also in the substance of the walls between those angles. In this latter situation they give rise to an inflation of the walls of the cells. In longitudinal sections the tubes are seen to have thin walls, which are very slightly thickened

* *Vide* Geol. Mag. new series, decade ii. vol. viii. p. 100 (Feb. 1881).

† This genus is defined by E. O. Ulrich (Journ. Cincinnati Soc. Nat. Hist. vol. v. p. 154, 1882) for the reception of such forms of the Monticuliporidæ as possess the following characters:—a ramose, free, or incrusting corallum, composed of cells of one kind only, the walls as seen in microscopic sections being thin in the axial but thicker in the peripheral region, and being provided with straight tabulæ. Spiniform corallites are developed more or less abundantly in different species, to such an extent in some as to completely surround the cell-mouths. The geological range of the genus in the United States extends from the Cincinnati group (Caradoc) to the "Sub-" Carboniferous (Mountain Limestone).

‡ Crenulate walls are found in *Monotrypa undulata*, Nich., *M. crenulata*, Nich., *Heterotrypa Dawsoni*, Nich., and in the present species.

as they approach in a gentle curve the surface of the corallum. Very few tabulæ are developed in the axial region of the corallum, and it is not until the surface is nearly attained that they occur in greater numbers. Here they are placed at irregular distances apart, and are often sharply curved either upwards or downwards. The minute crenulations of the walls are seen in these sections (see woodcut, fig. D). The minute-



Amplexopora microstoma, Foord.—A. Corallum of this species of the natural size. B. Tangential section, enlarged about 30 diameters. C. Part of the same section, enlarged about 50 diameters. D. Longitudinal section, showing at *a* one of the spiniform corallites, enlarged about 15 diameters.

ness of the corallites separates this species from all others of the same genus known to the writer.

Formation and Locality. Wenlock Limestone, Dudley.

3. *Dekayella* * *robusta*, Foord. (Pl. XII. figs. 2–2 *d.*)

Corallum ramose, frequently branching. Branches thick, usually cylindrical or subcylindrical, sometimes compressed. Surface covered with small but tolerably conspicuous monticules, situated about 3 millimetres apart, and bearing cells of a somewhat larger size than those in the intermediate spaces. The apertures of the corallites are polygonal in outline, and in places where the surface is well preserved some of the larger of the spiniform corallites may be seen with a hand-lens. Of the larger corallites about four occupy the space of 1 millimetre, of the smaller about five.

Microscopic characters.—Tangential sections reveal clearly the dimorphic character of the corallum, which is provided with two kinds of tubes, large and small; both are of polygonal form, and their outline is inflated in many places by the occurrence of numerous spiniform corallites. These also are of two kinds: the larger are usually situated at the angles formed by the junction of four or five cells, and fill a space quite as great as that occupied by some of the interstitial cells; the smaller are generally found to be in the substance of the cell-walls, about midway between two angles. The spiniform corallites form a very conspicuous feature in tangential sections of this species, and give to such sections a highly characteristic appearance. Under a moderately high power traces of the original walls of the corallites may be discerned in tangential sections; but as a rule this structure appears to have been destroyed in the process of fossilization. In longitudinal sections the two sets of tubes are clearly brought into view. In the larger ones there are numerous horizontal, sometimes slightly oblique, tabulæ, situated at from one half to one tube-diameter apart; they begin in the axial region of the corallum, and are about equally developed in their course from thence to the peripheral region. The smaller tubes do not differ in the character of their tabulation from the larger ones, except that the tabulæ in the former are a little more frequent than they are in the latter. There is a feature worthy of note in the structure of the walls of this species, and that is a periodic inflation, which reminds the

* Mr. E. O. Ulrich ("American Palæozoic Bryozoa," Journ. Cincinnati Soc. Nat. Hist. vol. v. p. 155, 1882) constituted this genus for the reception of forms "more nearly allied to *Dekayia*, Edwards and Haime, than to any other genus of the Monticuliporidæ," but differing therefrom "in having the tube-walls in the mature region of the zoarium thicker, in having numerous interstitial tubes, and, instead of one, two distinct sets of spiniform tubuli" [="spiniform corallites" of Nicholson]. This last is stated by Mr. Ulrich to be the most important character of the genus.

observer of a similar structure characteristic of the genus *Stenopora* (Lonsdale). Mr. Ulrich draws attention to a like feature in his description of a Cincinnati-group species of *Dekayella*—*D. obscura*, Ulrich (Journ. Cincinnati Soc. Nat. Hist. vol. vi. p. 150).

On leaving the axial region the tubes rapidly thicken towards the surface, the spiniform corallites being seen at frequent intervals piercing the corallum and intermingling with the ordinary corallites. The spiniform corallites appear to originate in the axial region of the corallum, as they may be seen in sections cut as deeply as it is possible to make them without destroying the walls of the tubes.

It may be well here to enumerate the chief characters which separate this species from the only two known to the writer, viz. *Dekayella Ulrichii*, Nicholson *, and *D. obscura*, Ulrich—both from the Cincinnati Group of Ohio. From the former of these the present type may be distinguished as follows:—by its much more robust habit of growth, by the possession of monticules, and by the much greater number of its tabulæ and spiniform corallites. The exceedingly small and delicate corallum of *D. obscura*, Ulrich, would be sufficient alone to differentiate it from *D. robusta*, and added to this the great development of the tabulæ and spiniform corallites in the latter make the distinction between the two forms sufficiently clear.

Formation and Locality. Cincinnati Group, Cincinnati, Ohio.

EXPLANATION OF PLATE XII.

Fig. 1. *Monotrypa macropora*, Foord: upper surface of corallum. Nat. size.
Fig. 1 *a*. Side view of the same specimen.
Fig. 1 *b*. Tangential section of this species, enlarged about 20 diameters.
Fig. 1 *c*. A few cells, enlarged about 50 diameters.
Fig. 1 *d*. Longitudinal section, enlarged about 15 diameters.
Fig. 2. *Dekayella robusta*, Foord: corallum, showing monticules. Nat. size.
Fig. 2 *a*. Tangential section of this species, showing the two series of spiniform corallites *a*, *a*. Enlarged about 30 diameters.
Fig. 2 *b*. Two cells, enlarged about 50 diameters.
Fig. 2 *c*. Longitudinal section, showing at *a* one of the spiniform corallites. Enlarged about 20 diameters.
Fig. 2 *d*. Portion of the same, showing more clearly the periodic inflation of the walls of the tubes. Enlarged about 50 diameters.

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* =*Monticulipora* (*Heterotrypa*) *Ulrichii*, Nicholson ('The Genus *Monticulipora*,' Nicholson, p. 131, fig. 22, 1881).

XXXVIII.—*A Collection of Butterflies from the Fiji Islands.* By Arthur G. Butler, F.L.S., F.Z.S., &c.

The collection of which the present is an account is one of unusual interest, from the great care with which it has been made, a record of the locality and date of capture being given upon each envelope. Of some of the species no examples have previously (so far as I know) reached this country, whilst of others we have only known single examples or a pair.

This series was collected by C. M. Woodford, Esq., and presented to the British Museum.

Nymphalidæ.

Euplœinæ.

Much discussion has arisen respecting Mr. Moore's revision of this group of butterflies, and there is no doubt that by the introduction into this otherwise most laboriously constructed paper, of unquestionably incomplete "tables of the genera," its author has laid himself open to criticism. Whether the groups regarded by Mr. Moore as genera are allowed to retain that rank or are regarded as sections, there can be no doubt that many of them are sufficiently distinct to exhibit series of parallel species, such as are recognized as existing between the universally admitted New-World genera *Ceratinia*, *Mechanitis*, *Melinæa*, and *Heliconius*. So far as I am personally concerned, I think a generic boundary separating such parallel series (even though it be only indicated by a slight constant modification in the wing-structure) is profitable to the student, in that it calls his attention to the existence of parallelism in the subfamily; and I think it convenient to admit the greater part of Moore's genera (in the present paper I admit all with which I have to deal), though in the case of *Andasena* and *Nipara*, I believe the latter name will not stand.

1. *Tirumala moderata.*

Danais moderata, Butler, P. Z. S. 1874, p. 275.

Tairuni, September 1882.

2. *Andasena eleutho.*

Danais eleutho, Quoy & Gaimard in Freyc. Voy. p. 554, pl. lxxxiii. fig. 2 (1815).

Mango, 20th July, 1882.

3. *Nipara intermedia.*

Nipara intermedia, Moore, P. Z. S. 1883, p. 258. n. 3.

♂ ♀. Mango, 13th and 18th July.

4. *Salpinx Græffiana.*

Euplœa Græffiana, Herrich-Schäffer, Stett. ent. Zeit. 1869, p. 70, pl. ii. fig. 5.

♀. Mango, 18th July, 1882.

5. *Vadebra mangoensis*, n. sp.

Dark piceous, primaries becoming almost black towards the end and around the end of the cell, but with the veins paler; a diffused submarginal paler band curving inwards to costa at apex, and bearing eight whity-brown spots, the four first of which form an oblique subapical series and are very small and almost white; the remainder increasing gradually in size to the seventh, the eighth considerably larger than the latter; external border smoky dark grey-brown: secondaries paler than the primaries, with an olivaceous tinge, the submarginal band wider and much paler than that of the primaries, bearing seven white spots near its inner edge, two of which are subapical and very sharply defined; four minute submarginal dots: body blackish. Wings below paler than above, olivaceous brown: primaries with the costal area pale, forming a continuous belt with the submarginal one; all the spots in the submarginal belt small, especially the fourth and fifth; a blue point near the extremity of the discoidal cell, and three forming an obtuse angle above the three median branches; an elongated white interno-median longitudinal streak; internal border dull white: secondaries with the submarginal belt very pale, especially towards the anal angle, so that only the first two of the white spots along its inner border are well defined; the four submarginal spots decidedly larger and more conspicuous than above; costal border, excepting at base, clear whity-brown; a blue spot in the cell and an angulated series of seven blue spots round the outer half of the cell between the veins, the last of these being distinctly linear; pectus and base of secondaries black spotted with white; venter dark brown, with a few central white points. Expanse of wings 52 millim.

Mango, 15th July, 1882.

Nearest to *V. sepulchralis* of Java and *V. Zinckenii* of Amboina; but readily distinguished from both by the discal series of spots on both surfaces and other less important characters.

6. *Callipl≈ìa Forsteri.*

Eupl≈ìa Forsteri, Felder, Reise der Nov. Lep. ii. p. 322 (1867).

Mango, 15th July.

Nymphalinæ.

7. *Hypolimnas formosa.*

Diadema formosa, Herrich-Schäffer, Aussereur. Schmett. fig. 119 (1869).

Mango, 16th July.

8. *Hypolimnas lutescens.*

Diadema lutescens, Butler, P. Z. S. 1874, p. 283. n. 49, pl. xliv. fig. 3.

♀. Mango, 16th July.

A dark form of this species was taken at the same time, which is interesting, inasmuch as it approaches *H. antilope* of Amboina. It is probably a female with male colouring.

9. *Hypolimnas pallescens.*

Diadema pallescens, Butler, P. Z. S. 1874, p. 282. n. 47.

Nine females. Mango, 18th July.

The series collected by Mr. Woodford shows a series of gradations, commencing with the extremely pale form figured in Brenchley's 'Voyage,' through a series of gradually darkening forms near to *H. antigone* of Batavia, to a smoky brown form in which the markings, excepting the discal series of white spots on the primaries, are much obscured; the general character of *H. pallescens*, apart from the ground-tint, is nevertheless retained throughout the series.

10. *Hypolimnas porphyria?*

Papilio porphyria, Cramer, Pap. Exot. iii. pl. cclv. E, F (1782).

♀. Tairuni, 16th September.

Cramer's figure is taken from an Amboinese example in which the submarginal series of spots appear to be decidedly whiter than in the Fijian form; this, however, may be an error in colouring.

11. *Hypolimnas Moseleyi.*

Hypolimnas Moseleyi, Butler, Ann. & Mag. Nat. Hist. ser. 5, vol. xi. p. 414. n. 43 (1883).

♀. Mango, 18th July.

It is a singular thing that the only male *Hypolimnas* in this collection is the specimen of *H. formosa.*

12. *Junonia villida.*

Papilio villida, Fabricius, Mant. Ins. ii. p. 35. n. 366 (1787).

Mango, 20th July.

Acræinæ.

13. *Acræa andromacha.*

Papilio andromacha, Fabricius, Syst. Ent. p. 466. n. 102 (1775).

18th and 20th July, 1882.

Lycænidæ.

14. *Catochrysops patala.*

Lycæna patala, Kollar, in Hügel's Kashmir, iv. 2, p. 419 (1848).

♂. Mango, 13th July, 1882.

15. *Jamides Woodfordii*, sp. nov.

♂. Brilliant glossy ultramarine-blue, with narrow external black border to the primaries about two thirds the width of that in *J. candrena* ($1\frac{1}{2}$ millim. in the middle, slightly wider at apex); costal margin very narrowly blackish: secondaries with a more or less well-developed submarginal series of oval black spots, bounded externally by a bluish-white line, those nearest to anal angle also with an internal bluish-white border; an interrupted black marginal line; abdominal border smoky grey, whitish at base: body blackish, with bluish and grey hairs on the thorax. Under surface rich golden brown, with the usual slender white lines; ocelli towards and at anal angle with reddish-orange internal lunate borders. Expanse of wings 29 millim.

♀. Paler than the male on both surfaces, the primaries above with costal and external blackish borders almost as wide as in *J. plato* ♀: secondaries with a complete marginal series of blind black ocelli, with pale blue irides and black zones. Expanse of wings 31 millim.

♂ ♀. Mango, 13th July.

We also have a male in the Museum from Vanua Levu.

16. *Jamides campanulata*, sp. nov.

Smaller than the preceding species, deep glossy sky-blue with lilac reflections; similar in pattern to the preceding species, but the submarginal line bounding the submarginal spots of the male and forming the irides of the ocelli of the female pure white. Under surface distinctly paler than in *J. Woodfordii*, of a stone-greyish colour; the lunules bounding the ocelli of secondaries golden-orange. Expanse of wings, ♂ 25, ♀ 27 millim.

♂ ♀. Mango, 13th July.

We also possess a male taken at Vanua Levu on the 3rd July, and a second from Viti Levu received in 1874 as a supposed variety of the far more beautiful *J. candrena.*

17. *Jamides lobelia*, sp. n.

♂. The smallest species of the group: bright *Morpho*-blue; primaries with a rather narrow black external border (just over 1 millim. in the middle, slightly wider at costa): secondaries with black submarginal spots much as in *J. Woodfordii*, but less oval. Under surface grey, the white lines indistinct, the ocelli of secondaries with pale stramineous internal lunate border. Expanse of wings 16 millim.

♂. Mango, 13th July *.

18. *Lycæna mangoensis*, sp. n.

♂. Violet-blue, rather dull; with narrow dull dust-grey external border, slightly wider at costa than at external angle;

* Before passing on to another genus I think it best to name two other forms which have for some time past stood in the Museum collection as supposed varieties of *J. candrena*, but which I now am sure are distinct.

Jamides pulcherrima, sp. n.

♂. Colour of *J. candrena*; intense glistening ultramarine-blue; primaries with the costal margin and a rather broad external border black, the width of this border gradually increased from 1½ millim. at external angle to 6 millim. on the costal margin, so that it is decidedly wider than in *J. candrena*, but narrower than in *J. plato*: secondaries also with a regular black border nearly 2 millim. in width, enclosing a series of blue crescents; abdominal border brown. Wings below stone-grey; white lines inconspicuous: ocelli of secondaries rather small, the larger one over the tail oval, with a greenish silver spangle at each end and, like the smaller one, with a narrow reddish-orange half-zone. Expanse of wings 26 millim.

Tanna, New Hebrides, 23rd April.

Jamides morphoides, sp. n.

♂. Brilliant *Morpho*-blue, with black borders as in the preceding species, that of secondaries enclosing three oval spots outlined in lilac. Under surface silver-grey, with a very faint golden shot, only visible in certain lights; the white lines on the primaries very indistinct; ocelli on the secondaries with ochreous inner borders. Expanse of wings 30 millim.

Montague Island, New Hebrides.

Nearest to *J. Goodenovii*, though entirely differing in the colour of both surfaces.

basal half of costa of primaries and abdominal border of secondaries chalky white: body bluish. Under surface greyish white; a narrow discocellular stone-grey stria with white edges at the end of each discoidal cell; a marginal series of grey-centred and grey-zoned white ocelli: primaries with a series of white-edged grey lunate spots near to outer margin: secondaries with two spots near the base and an irregularly angulated series of white-edged stone-grey spots beyond the middle. Expanse of wings 25–27 millim.

Mango, 20th July, 1882.

Not very nearly allied to any thing known to me.

Papilionidæ.

Pierinæ.

19. *Belenois teutonia?*

Papilio teutonia, Fabricius, Syst. Ent. p. 474 (1775).

Mango, 20th July.

Not perfectly typical; but only one example was obtained.

20. *Belenois clarissa.*

Belenois clarissa, Butler, Ann. & Mag. Nat. Hist. ser. 5, vol. xii. p. 590 (1873).

Mango, 13th July.

Two males were obtained.

Papilioninæ.

21. *Papilio Schmeltzi.*

Papilio Schmeltzi, Herrich-Schäffer, Stett. ent. Zeit. 1869, pl. i. fig. 1.

Levuka, 29th June; Mango, 15th July.

No species of Hesperidæ were obtained.

XXXIX.—*A Contribution to the Knowledge of the Marine Fauna of Kurrachee.* By J. A. Murray.

The marine fauna of Kurrachee and the Sind coast generally has not hitherto received quite the attention it deserves, and it is evident, from the results of collections made during the last five years, that there are many undescribed forms, not only of mammals, but also of fish, Crustacea, and the lower organisms, as Echini, Polyzoa, Zoophytes, &c.

In this paper I shall describe two new species—one a Shark of the genus *Lamna*, and the other a Cetacean of the family Delphinidæ, and of the genus *Neomeris*.

Taking the Shark first, it is necessary to make mention of a species from the Kurrachee harbour, which Dr. Günther, of the British Museum, described in the 'Annals and Magazine of Natural History' for February 1883, under the name of *Carcharias Murrayi*. It is quite possible that this species would be found to occur on the Mekran, Kutch, and Bombay coasts also; but at present I am not aware of its distribution east or west. The several imperfect jaws in the Kurrachee Museum from Kutch lead me to believe that the species occurs on that coast also.

The new species of the genus *Lamna* requires but little preface. According to Dr. Günther (Cat. Fish, Brit. Mus. vol. viii.) the genus contains only three species, viz. *L. cornubica*, *L. Spallanzani*, and *L. glauca*. Of these *L. Spallanzani* is mentioned by Mr. Day as occurring in the Indian Ocean, and a figure of the species is given by him on plate 186 of his work on the Fishes of India, taken from a drawing by Sir Walter Elliot of an example captured at Madras.

The present species is not *L. Spallanzani* nor any of the other described forms, from all of which it differs very materially, first in having a greater number of teeth, next in the position and shape of the fins, also in the position and shortness of the keel on the sides of the tail; and, lastly, in having a very prominent lateral line or ridge extending from the lateral keel of the tail forwards along the entire length of the body, rising upwards above the gill-openings and terminating immediately behind the eye.

The species now needs a name, and I venture to associate with it that of our veteran ichthyologist, and describe it as

Lamna Güntheri, sp. nov.

Its measurements as taken in the flesh are as under:—

	feet.	inches.
Length from tip of snout to root of caudal ..	7	2
From root of caudal to tip of upper caudal lobe	1	6
From root of caudal to tip of lower caudal lobe	1	$0\frac{1}{2}$
Distance between tips of upper and lower caudal lobes	1	5
Length of pectoral fin	1	4
Width of pectoral fin at base.............	0	$8\frac{1}{2}$

	feet.	inches.
Height of dorsal fin	0	9
Width of dorsal fin	0	9
Distance of dorsal from base of pectoral fin	0	$4\frac{1}{2}$
Distance of pectoral from base of ventral	1	$10\frac{1}{2}$
Height of anal fin	0	$2\frac{1}{4}$
Height of second dorsal	0	$2\frac{1}{4}$
Girth round body at third gill-opening	3	10

Teeth $\frac{22}{28}$.

The snout is much produced and subtriangular; from the front of the eye to the tip of the snout it measures $6\frac{1}{2}$ inches, and the space between the eyes is 6 inches. From the front of the eye to the tip of the snout on each side is a band, $\frac{1}{2}$ inch wide, of a series of irregularly arranged minute pores, and there is a similar patch on the cheeks and below the snout, but extending only to within 2 inches of the gums. The nostrils are conspicuous, open, and placed nearer the eye than the tip of the snout; the greatest diameter of each is 0·37 inch. The angle of the mouth is midway between the nostril and first gill-opening. Gill-openings five, all of equal width. Teeth $\frac{22}{28}$, their edges sharp and smooth, no basal cusps. The first set of three in the lower jaw is longest, and measures from 1·25 to 1·37 inch in length, curved inwards, rather flattened on the outer side and convex or rounded on the inner. The third tooth on each side of the symphysis of the upper jaw is smaller than the rest.

The first dorsal fin is placed nearer the pectoral than the ventral fin, and about its own length behind the hinder base of the pectoral; pectoral fin narrowing falcately from the base to the tip; anal fin situated about its own length posteriorly to the second dorsal. A pit at the root of the caudal fin. The keel on the sides of the tail begins from in line with the origin of the anal fin; a strongly ridged lateral line is continued from it, extending along the entire length of the body, rising upwards above the gill-openings, and terminating immediately behind the eye. Upper caudal lobe falcate, terminating in a point and not in a triangular lobe, as shown in the figure of *L. Spallanzani* in Mr. Day's work. Colour dark plumbeous on the upper half, greyish on the lower half; underside of snout yellowish. Skin smooth.

The synopsis below will show at a glance how this species differs from the other described forms :—

	Teeth.	Gill-openings.	Dorsal fin.	Lateral l
L. Güntheri, sp. nov.	$\frac{22}{23}$ on each side. No basal cusps.	Gill-openings all of equal width.	Origin of dorsal fin nearer pectoral than ventral.	Prominen
L. cornubica	$\frac{13-16}{12-14}$. A small basal cusp on each side.	Width of first gill-opening nearly equal to its distance from the last.	Above the root of pectoral.	?
L. Spallanzani	$\frac{13}{13}$. No basal cusps.	Rather more than its distance from the last.	Short distance from base of pectorals. Second dorsal and anal opposite one another.	?
L. glauca	$\frac{13}{13}$. No basal cusps.	Ditto.	Ditto.	

The next is a Cetacean of the family Delphinidæ, which I shall describe under the name

Neomeris kurrachiensis.

The characters of the genus are :—Dorsal fin none. Nose of skull short, rounded in front, flat and shelving above. Teeth numerous, compressed, nicked, acute, extending nearly the whole length of the jaw (Gray, 'Seals and Whales,' &c.).

Neomeris phocænoides is the only species of the genus, and its dentition is given as $\frac{16}{16}$ (*Delphinus melas*) or $\frac{20}{19}$ on each side.

The species under notice has $\frac{18}{18}$ teeth on each side, and there are besides a set of $\frac{3}{2}$, which were scarcely visible through the gums, and situated out of the line of the other teeth in front of the jaws. In shape these $\frac{3}{2}$ teeth are quite unlike the rest, being conical instead of flattened or compressed.

The measurements of the animal taken in the flesh are as under :—

	inches.
Length along curves from tip of snout to notch between caudal flukes	52
Ditto, straight	45
Tip of snout to pectoral fin	10
Caudal flukes	9×3
Distance of blowhole from tip of snout along curve...........................	6·5
Ditto from angle of mouth to eye	1·62
Vent from root of caudal fin	14

Snout rounded; head very convex, rising posteriorly high to the dorsal surface. Blowhole semilunar. Back with a longitudinal band of spinous tubercles on the vertebral area, beginning nearly opposite the root of the pectoral, widening to 1·5 inch about the middle, and again contracting and ending narrowly opposite or in line with the vent. No dorsal fin. Pectoral subfalcate. Teeth $\frac{18}{18}$. Colour shining black throughout, except a purplish-red patch in front of the snout (on the upper lip) and on the throat. Intestines 31 feet in length. Contents of stomach Crustacea (species of *Penæus*).

Skull.

	inches.
Length of skull over curves to upper edge of foramen magnum	10
Ditto, straight from below	8
Height of skull (vertex of superoccipital)	4·25
Tip of snout to blowhole	4·25
Ditto to interparietal	6·25
Interparietal to upper edge of foramen magnum	3·75
Across maxillaries	4·75
Across blowhole	1·5
Length of malar	2·0
Ditto of brain-cavity	4·0
Across paroccipitals	3·37
Greatest space between occipital condyles (upper)	1·5
Smallest space between occipital condyles at lower third	1·0
Vertical diameter of foramen magnum	1·75
Breadth across last teeth on each side (upper jaw)	2·5
Ditto, ditto (lower jaw)	2·5
Teeth-line in upper and lower jaw	2·5
Length of lower jaw to coronoid process	5·62
Greatest vertical depth of ramus	2·62
Palate	4·0

The superoccipital is subglobular and very convex above. Rostrum short, rounded in front. Foramen magnum vertically oval, with the occipital condyles vertically elongated and convex, wider at their lower third. Teeth small, flattened, or compressed, with a sharp subcrescentic crown, faintly nicked, and with the middle of their outer and inner sides slightly swelled; they are rather obliquely arranged in line, about one fifth of each succeeding hinder one overlapping its fellow, but not in contact.

XL.—*Note on the assumed Relationship of* Parkeria *to* Stromatopora, *and on a Microscopic Section of* Stromatopora mamillata, *Fr. Schmidt.* By H. J. Carter, F.R.S. &c.

In 1877 ('Annals,' vol. xix. p. 55 *et seq.*) I made it plain (at all events to myself) that *Parkeria* was neither a species of Foraminifera nor one of Spongida; and at p. 61 (*ib.*) began to compare the structure of *Parkeria* with that of *Stromatopora*, meaning that stromatoporoid organism of the Devonian Limestone called by Phillips "*Caunopora placenta*," which was originally described by Lonsdale under the name of "*Coscinopora placenta.*" But subsequently, that is in 1879 ('Annals,' vol. iv. p. 101 *et seq.*), I found that *Caunopora* must be considered as an instance of "symbiosis," in which the vertical tubes belonged to one organism and the stromatoporoid mass in which they are imbedded to another, probably both allied to the Hydroida; thus my comparison of the "vertical tubes" of *Caunopora* with those of *Parkeria* became inadmissible, and the nature of the animal of *Parkeria* was still left open for conjecture.

To assume that *Parkeria* was not a Hydroid because the skeletal structure of the former was probably calcareous and not chitinous would be equally inadmissible, because *Hydractinia calcarea* affords a living instance to the contrary, to say nothing of the fossil species, viz. *H. pliocena* ('Annals,' 1877, vol. xix. p. 50) and *H. Kingii* (*ib.* 1878, vol. i. p. 301), both of which are of considerable thickness. Thus, prevalent as the chitinous skeleton is among the Hydroida, there are instances of calcareous ones in which the structure *mutatis mutandis* is the same; but to this I shall presently recur more particularly.

Meanwhile fossil specimens of massive Polyzoa from the Coralline Crag of Suffolk have been presented to me to show how much their general form, structure, and mode of growth resembles that of *Parkeria*; that is, they are hemispherical masses with nodular segmented surface, radiating structure, and concentric lines of intervals or chambers (analogous to the "chamberlets" in *Parkeria*), all growing from a central point and furnished with an epithecal investment. But, while the segments are composed of little groups or masses of *parallel tubes in juxtaposition*, which groups are separated in the direction of the radiation by the intervening of the "chambers," and each mass is based upon an epithecal layer of amorphous substance which extends more or less up the sides, thus forming the ceiling of the *empty* "chamber," whose floor, on the other hand, consists of the open mouths of the tubes in juxtaposition, as seen on the surface of the fossil, the *whole* of the structure of *Parkeria* is elaborated out of tissue composed of anastomosing, reticulated and vermiculated, solid, calcareous thread in which there is no epithecal or other differentiation whatever beyond form; that is to say, that although this tissue is traversed by *distinct* tubes which radiate in broken lines from the centre to the circumference (passing *through* the chambers in an isolated manner, that is, separated for some distance from each other without any intervening substance, which chambers, as before stated, are *empty* in the fossil Polyzoa from the Coralline Crag), the tubes themselves of *Parkeria* are composed of the same reticulated tissue as the rest of the fossil. In both instances, of course, these calcareous structures respectively represent the skeletal or hard parts, while the intervals were occupied by the soft parts of the animal.

Again, the embryo or commencement of *Parkeria* seems to have settled, for development, on a loose or rolling fragment of foreign material, whence the future growth became more or less spherical, often including in its progress small Foraminifera and other particles of foreign matter, as may be seen by the vertical sections.

Thus the resemblance of the fossilized Polyzoa of the Crag to *Parkeria* is reduced to the general structure, while the elementary structure is *totally* different.

Where *Parkeria* looks most like the fossilized forms of the Polyzoa from the Crag is in the solidified specimens, that is, where the cavities originally occupied by the flesh or soft parts have been filled up with calcite; but this is not the condition in which the comparison should be made, seeing that, in many instances when the *Parkeria* is broken with a hammer, more or less of the interior comes out in a large spherical form or nucleus, like a nut from its shell, wherein the whole of the calcite, which in the solidified specimens fills the intervals originally occupied by the soft parts, is absent, and therefore nothing but the tissue formed of the anastomosing, reticulated, skeletal thread, now incrusted with minute crystals of calcite through fossilization, remains, which nucleus, on being picked to pieces as much as may be required, can be most satisfactorily studied, and then it is that the great difference which exists between it and the fossilized Polyzoa of the Coralline Crag can be fully realized. Indeed, in this condition, the skeletal part can be more satisfactorily studied even than in the living animal, when the whole of the skeleton was probably imbedded in flesh.

But whether the reticulated tissue of anastomosing, vermiculated thread be infiltrated or not, the distinction between the tubes and this tissue is equally manifest, from the small size of the meshes of the latter contrasted with the much larger size and scattered position of the former, either on the surface of the fossil or in the vertical section, as they traverse the chamber; at the same time if the surface *alone* be examined, then it *does* resemble that of the Polyzoa called "*Heteropora*" (large and small tubes together); but this impression is soon corrected by an examination of the *un*infiltrated or *un*consolidated specimen, when the "tubes," which on the surface look like *Heteropora*, are seen to be separated by an intervening structure that, to my knowledge, hitherto has, in no shape, ever been found to occur with the cells of the Polyzoa.

What, then, was the form of the animal that inhabited these tubes in the midst of the elementary structure of *Parkeria*, which is so totally different from that of the fossilized Polyzoa of the Coralline Crag, to which I might add those of the Coral Rag and the recent species of branched coralliform polyzoon, called "*Heteropora*," from New Zealand?

This question throws us back again upon the Hydroida, to which I have before alluded as presenting in the *calcareous* form the only kind of reticulated tissue mixed with large tubes (the calicles) for the use of the polyps or hydranths which have any direct resemblance to the structure of *Parkeria* (see 'Annals,' 1877, vol. xix. p. 50, pl. viii. fig. 5, &c.).

If we assume that *Parkeria* was a polyzoon, then it must be entirely upon general resemblance and form, but not at all upon the elementary structure; hence the assumption must be so far *simply* conjectural; while if we assume that it was a Hydroid, then we have in addition an almost identity in elementary structure to go upon for our assumption, and this being, under the circumstances, of *the more* consequence of the two, must be considered the more tenable. Besides, we have the instance of *Chitina ericopsis* ('Annals,' 1873, vol. xi. p. 13), which, although dendritic in general form, is identical in tissue with *Parkeria*, that is, the whole is elaborated out of a mass of continuous, anastomosing, reticulated, and vermiculated thread, without differentiation in any part beyond mere form; and although there are no "chambers" here to be traversed by the "tubes," as in *Parkeria*, their analogues are to be seen in the form of hollow cylindrical processes or hydrothecæ at the *ends* of the branches, which tubes are composed of the same tissue and originally contained the polyps or hydranths. Now, were this "thread" calcareous instead of chitinous, as it *is* in *Hydractinia calcarea*, then the identity in structure with *Parkeria* would be so far complete.

Thus, although *Parkeria* cannot be identified with *Caunopora*, there is still no reason whatever why it should not be indirectly connected through *Hydractinia* with *Stromatopora* by being a Hydroid, if I am right in assuming that the animal of the latter was of this nature ('Annals,' 1878, vol. ii. p. 304 &c.).

With reference to the examination of the microscopic section of *Stromatopora mamillata*, Fr. Schmidt (Rosen, "Ueber die Stromatoporen," p. 71 &c., Taf. viii.), I have only to repeat what Nicholson and Murie, in their excellent memoir, have already stated, viz. that the skeleton of *Stromatopora* is "composed of non-spicular, granular, calcareous matter" (Linn. Soc. Journ. Zool. 1878, vol. xiv. p. 241).

Selecting a rolled portion, from the "Parson and Clerk" rocks at Teignmouth, of the species above mentioned, in which the so-called "hexactinellid structure" is sharply defined, I thought, as I had lately been successful in bringing out the spicules of the fossilized Calcispongiæ of the Coral Rag from Faringdon, that I might be equally successful in doing so with *Stromatopora* under similar circumstances, if there were any present; but although the slice was reduced almost to transparency, the skeletal fibre of the *Stromatopora* throughout never presented any thing but a granular composition, the minute grains of which contrasted strongly with the clear rhomboid crystalline calcspar of the intervening spaces, without the most remote trace of any kind of sponge-spicule in any part.

XLI.—*Contributions towards a General History of the Marine Polyzoa.* By the Rev. Thomas Hincks, B.A., F.R.S.

[Continued from vol. xi. p. 202.]

[Plates XIII. & XIV.]

XII. POLYZOA FROM INDIA (coast of Burmah).

A small gathering of Polyzoa from an island in the Mergui Archipelago, off the coast of Burmah, obtained by Dr. J. Anderson, F.R.S., Superintendent of the Indian Museum, Calcutta, has been placed in my hands for examination by my friend Mr. H. J. Carter. It consists of fourteen species, of which four are probably undescribed; the rest are well-known forms, but they have a definite interest as coming from a new locality, and one which has hitherto, so far as I know, been little explored.

The following is the list of species:—

Suborder CHEILOSTOMATA.

Family **Cellulariidæ**.

SCRUPOCELLARIA, Van Beneden.

Scrupocellaria diadema, Busk.

Range. Queensland.

Family **Bicellariidæ**.

BEANIA, Johnston.

Beania mirabilis, Johnston.

On shell.
Range. Scandinavia, Great Britain, Adriatic.

Family **Membraniporidæ**.

MEMBRANIPORA, De Blainville.

Membranipora favus, n. sp. (Pl. XIII. fig. 2.)

Zoœcia oval, or hexagonal, or suborbicular (presenting many irregularities both in form and arrangement), of considerable depth, closely packed together, surrounded by a narrow brown line, which forms a kind of keel on the top of the cell-wall; inner surface of the margin granular; area occupying the whole front of the cell, closed in by a delicate membrane; numerous small cells of various shapes (sometimes quadrate, with an orbicular area) interspersed amongst the larger ones. *Avicularia* none.

Zoarium forming a rather thick crust, and (especially in the absence of the membranous front wall) closely resembling a honeycomb.

The species is without striking features. The dwarf cells, which are present in large numbers, are, perhaps, the most notable peculiarity.

Membranipora marginella, n. sp. (Pl. XIII. fig. 1.)

Zoœcia rather small, quincuncially arranged, ovate or pyriform, sometimes pointed below, with a rather thick, unarmed, minutely granular margin; aperture occupying about two thirds of the front and closed in by membrane, contracted above and expanded and rounded below; a small oval *avicularium*, elevated above and sloping downwards, borne on the margin of the zoœcia, usually placed on the side, near the top. Occasionally cells with a very large oral operculum of a dark horn-colour, occupying nearly half the area, and enclosed by a thin raised border (? avicularian or reproductive).

Family **Steganoporellidæ.**

Steganoporella, Smitt.

Steganoporella magnilabris, Busk.

Range. Abrolhos Islet (south tropical Atlantic), Algoa Bay, Bass's Straits, Florida.

Smitt places this genus amongst the Microporidæ, and I have given it the same position in my 'History of the British Marine Polyzoa.' But I am now inclined to agree with Dr. J. Jullien * so far as to regard the dithalamic condition of the zoœcium which distinguishes it as entitling it to rank in a separate *family* group. It is only right, however, that the name of this group should be taken from Smitt's genus *Steganoporella*, which is founded on the division of the zoœcium into an upper and lower chamber by the interposition of a calcareous lamina beneath the membranous front wall.

I am unable to follow Dr. Jullien in his proposed distribution of the Cheilostomata into two principal groups, characterized by the presence or absence of this "double ectocyst." It seems to me that he assigns a significance to this structural peculiarity to which it is by no means entitled. There is room, however, for a fuller investigation of its history and meaning.

Smittipora, J. Jullien.

Smittipora abyssicola, Smitt.

Range. Cuba, Florida, Singapore or Philippines.

* See his interesting paper entitled "Note sur une nouvelle division des Bryozoaires Cheilostomiens," Bull. de la Soc. Zool. de France, t. vi. (1881).

There seem to be two generic types at least* included in the group of the Steganoporellidæ, one of them represented by *S. magnilabris* and the forms which agree with it in the structure of the zoœcium, the other by such forms as the present. For the latter I have adopted (provisionally) Jullien's name *Smittipora*, though I am not prepared to accept his diagnosis of the genus in all points, and should be disposed to make it much more comprehensive than he has done. The genus *Steganoporella* (as I propose to limit it) is distinguished by the tubular passage leading from the inner chamber towards the external orifice and the corresponding modification of the internal orifice ("*opesia*" of Jullien), which is a simple opening in the calcareous lamina communicating directly with the inner chamber in *Smittipora* and kindred forms †.

I at one time referred the present species to *Setosella*, mihi, but the British species (*S. vulnerata*) for which this genus was founded does not possess the dithalamic cell.

The specimens of *S. abyssicola* from Burmah are crustaceous in habit.

Family **Microporellidæ.**

Microporella, Hincks.

Microporella violacea, Johnston, form *plagiopora*, Busk.
(Pl. XIII. fig. 3.)

Range. Off Tortugas, Florida; France (south-west): English Coralline and Red Crag, Italian Pliocene.

Zoœcia large, ovate, very irregularly placed, punctured or areolated round the margin; orifice (primary) arched above, lower margin straight; peristome often much raised, giving a tubular character to the orifice; pore subcentral, simple, round; *avicularium* originating a little below the orifice, bent towards one side of it, and extending obliquely to the margin; mandible slender and finely pointed, curved at the extremity.

The Burmese specimens agree in all essential particulars with Busk's Crag species. The only peculiarities are the very irregular arrangement of the zoœcia and the elevated tubular peristome which occurs on many of the cells. I see no reason for regarding *M. plagiopora* as any thing more than a slightly modified form of *M. violacea*.

* There are probably more, but I confine my attention at present to the two noted above.

† See 'Annals' for Feb. 1882, "Contributions towards a General History of the Marine Polyzoa."—IX., pl. v. figs. 8, 9.

Microporella Fuegensis, Busk.

Range. Tierra del Fuego.

A small erect and branched specimen of this species occurs. The suboral pore presents some peculiarities. It is placed *immediately* below the rim of the orifice in front, and is only found in the adult cell. In the marginal zoœcia the orifice is suborbicular and the peristome not elevated; but in a more advanced stage the peristome rises considerably round the back and sides of the orifice, but not in front, the result being that a sinus is formed here. In a still more advanced stage the *margin* of the side walls of the peristome is extended across the upper part of this sinus, forming a narrow rim, and converting the open fissure into a circular pore, which communicates directly with the interior of the tubular peristome. It is evident that this is a very different structure from the ordinary pore of the *Microporellæ*, as it occurs in *M. ciliata* and *M. Malusii*, where it opens into the interior of the cell itself, and must be placed in a very different category.

Family **Myriozoidæ** (part), Smitt.

SCHIZOPORELLA, Hincks.

Schizoporella biaperta, Michelin.

The single specimen which occurs is crustaceous in habit and referable to the form *divergens* of Smitt. It is furnished with large spatulate avicularia as well as the small circular form so characteristic of the species; the walls of the cell are smooth and white. The oœcium is very unlike that figured by Smitt for his *Hippothoa* (*Schizoporella*) *biaperta*; and this dissimilarity, in conjunction with the difference in the shape of the orifice, may prove that he was right in regarding the form *divergens* as a species. The ovicell in Dr. Anderson's specimen (which is a very typical example of Smitt's *S. divergens*) is small, rounded, and thickly covered with raised punctures; the opening is closed by the oral operculum of the cell.

Family **Escharidæ** (part), Smitt.

LEPRALIA, Johnston (part).

Lepralia robusta, n. sp. (Pl. XIII. fig. 4.)

Zoœcia very large, ovate, quincuncial, flattish, separated by a rather deep furrow, which is occupied by a line of large punctures; surface uneven, rather coarsely granulose, usually a small depression (? pore) in the centre; orifice large, much taller than wide, arched and expanded above, somewhat contracted below, constricted a short distance above the inferior margin, which curves outwards; on each side of the orifice (or sometimes on one side only) a much elongated subspatulate *avicularium*, which originates some way below the orifice and slants obliquely upwards to a little above the top of it; mandible long, blunt and slightly expanded at the extremity, and directed upwards. *Oœcium* rounded, somewhat prominent, moderate in size, surface roughened.

A fine characteristic member of the genus, of which the size of the cells and the elongate avicularium are the striking features.

PORELLA, Gray.

Porella malleolus, n. sp. (Pl. XIII. fig. 5.)

Zoœcia rectangular, disposed in linear series, depressed, separated by delicate raised lines; surface covered with small punctures and nodulous ridges; a line of larger foramina round the sides; orifice arched and expanded above, much contracted below, the margin about the centre projecting inward on each side, lower lip slightly curved (nearly straight); within it an *avicularium* with a hammer-shaped mandible. Occasionally an *avicularium* at one side, which takes its origin some way down the cell and slopes upward to the top of the orifice; mandible elongate, slightly expanded at the base, slender above it, and pointed at the extremity, directed upwards. *Oœcium* (?).

Zoarium incrusting, whitish, of very delicate material.

The hammer-shaped mandible of the avicularium is a curious peculiarity, and, when elevated and standing erect within the lower lip, a very conspicuous one.

SMITTIA, Hincks.

Smittia trispinosa, Johnston, vars.

Range. Norway and Arctic seas, St. Lawrence, Mazatlan, North Pacific (Queen Charlotte Islands), Florida, Cape Horn, Aden, Adriatic, Britain, Bass's Straits.

Of this cosmopolitan species several varieties occur.

i. Peristome usually not elevated, and the marginal denticle very prominent (as in the Arctic form); sometimes the usual triangular *avicularium* present, but in some of the cells replaced by an elongate form, originating below the orifice, and stretching up alongside it, with a long slender mandible (occasionally subspatulate) directed upwards. *Zoœcia* very irregularly placed and turned in all directions (Pl. XIII. figs. 7, 7*a*).

ii. *Zoœcia* very regularly disposed in lines. *Oœcium* thickly punctured, and with a penthouse-like projection in front; a triangular *avicularium* below the orifice.

iii. Form *bimucronata* (Pl. XIII. fig. 6). *Zoœcia* ovate, moderately convex, in linear series, radiating regularly from the central primary cell, separated by raised lines, punctured round the margin; surface reticulated, silvery; orifice suborbicular, with a denticle on the lower lip; peristome (in the older cells) much elevated, thin, rising on each side into a prominent mucronate process, more or less produced in front, two spines on the upper lip; frequently on one side a gigantic *avicularium*, which originates alongside the peristome (near the top of the orifice), and extends straight downwards to the base of the cell; beak deeply channelled, broad at the base, and narrowing gradually towards the rounded extremity; an elongate subtriangular opening on the upper half of it; mandible long, very slender above the expanded basal portion, formed of very delicate membrane, directed downwards.

This variety also occurs in Australia (*J. B. Wilson*).

This has much the appearance of a distinct species; but it is connected by intermediate varieties with the typical form. We might expect the most widely distributed forms to be the most liable to variation; and this is certainly so in the case of the present species and *Microporella ciliata*, which are both eminently cosmopolitan.

Family **Celleporidæ**.

CELLEPORA, Fabricius (part).

Cellepora, ? n. sp.

A *Cellepora* occurs amongst Dr. Anderson's specimens which is identical with that described in my "Report on the Polyzoa of Queen Charlotte Islands" under the provisional name of *C. brunnea*.

Suborder CYCLOSTOMATA.

Family **Lichenoporidæ**.

LICHENOPORA, Defrance.

Lichenopora Novæ-Zealandiæ, Busk.

Range. New Zealand.

XIII. POLYZOA FROM VICTORIA AND WESTERN AUSTRALIA.

Under the present heading I shall continue the account of the Polyzoa dredged by Mr. J. Bracebridge Wilson off Port Phillip Heads, Victoria *. The collection which he has placed in my hands for examination is large and interesting, and I propose to give a complete list of the species contained in it which are not included in MacGillivray's 'Decades,' as well as descriptions of the new forms.

Group *Entoprocta*.

Family **Pedicellinidæ**.

Pedicellinopsis, n. gen.

Generic character.—*Polypides* cup-shaped, supported on chitinous tubes with a much enlarged base (consisting of an opaque white core, probably muscular, enveloped in a chitinous covering), by which they are attached to an erect tubular stem. *Zoarium* adherent by means of tubular root-fibres.

This is a truly arboresent *Pedicellina*, in which the soft parts, with the exception of the polypide itself, are clothed with a well-developed chitinous cœnœcium. The prolongation of the common flesh from which the polypide buds is protected by a chitinous tube, which is open above, and at the base is attached to a stem (also invested with a solid periderm). The root-fibres by which the colony is fixed in its place are sheathed in chitine. The polypide resembles closely that of such a form as *Pedicellina cernua*, and, so far as I can judge from an examination of spirit-specimens, presents no special peculiarities; it is not elevated above the orifice of the tube, but rests immediately upon it. The base of the tube is modified for the reception of a special structure; and if we may judge from the analogy of such a species as *Pedicellina gracilis*, Sars †, it must be muscular in character, and probably much more powerful and highly organized, as it is much larger than the kindred structure which occurs in the latter. If it be muscular it must secure free mobility to the polypide in conjunction with the protection afforded by the solid covering, and

* See 'Annals' for August 1882.

† In this form the mobility resides in the enlarged cylindrical base, the stem merely bending from the bottom, and the upper portions being chitinous and rigid.

a colony of *Pedicellinopsis* in health and vigour must present a strange scene of unrest and lively movement. We may hope that Mr. Wilson may yet have an opportunity of examining the species alive and studying its habits.

This localization of the muscular power seems to me to be fairly accounted a generic character; and I should be disposed to separate *Pedicellina gracilis* from the species in which it is diffused and in which there are no chitinous elements. At the same time it must be remembered that Leidy has described an American form very closely resembling *P. gracilis,* in which the basal expansion is present, while at the same time the whole stem is highly flexible and often becomes "more or less revolute" *. This is certainly a transition form. The distinctive characteristics of *Pedicellinopsis* are the arborescent form (which is by no means comparable with the mere ordinary variations in habit amongst the calcareous Cheilostomata), the specialized muscular structure, and (primarily) the highly developed periderm. In the localization of the muscular power this genus agrees with *Pedicellina gracilis* and with the remarkable Arctic genus *Barentsia,* mihi. In the possession of the first of the characters named it stands alone amongst the tribe; the last it shares (though with an important difference) with *Urnatella,* Leidy, a very interesting and beautiful form from the American fresh waters.

Pedicellinopsis fruticosa, n. sp. (Pl. XIV. figs. 3–3 *c.*)

Zoarium erect, consisting of a number of stout chitinous stems rising from a mat of tubular root-fibres, and sending off branches sparingly and irregularly, the whole forming a bushy shrub-like growth. *Polypides* borne on the summit of tall chitinous tubes, obliquely truncate at the top, and produced at the upper side into a sharp spinous projection, terminating below in large turbinate expansions with an opaque-white core and chitinous envelope, annulated throughout, which are attached to the stem by the inner side towards the base, and are thickly crowded upon it; body of the polypide cup-shaped, whitish, ventricose on one side and almost straight on the other; tentacles (probably) about twenty; the tubes traversed by four double lines, the spaces between them being occupied by a row of minute disks, which project from the surface. Height of the zoarium about one inch.

Loc. Port Phillip Heads (*J. B. Wilson*).

The tubes are densely crowded on the stems, which they

* See his paper entitled "*Urnatella gracilis,* a Freshwater Polyzoan," Journ. Ac. Nat. Sci. Philad. vol. ix.

clothe throughout their whole length; they are disposed somewhat irregularly in whorls. The basal enlargements are closely packed together, and almost conceal the surface of the stem. There is little branching; near the base the stem divides into two principal shoots, which give off laterals occasionally, but there is no definiteness in the plan of the ramification. The whole surface of the tubes is finely lineated longitudinally. A very marked character of the species is the obliquely truncate extremity of the tube, which is produced on one side into a strong spike-like projection. Towards the base the stem gives off a large number of chitinous fibres, which form a kind of adherent disk.

The whole structure recalls very forcibly one of the Tubularian Hydroids.

Group *Ectoprocta.*

Suborder Ctenostomata.

Family **Flustrellidæ.**

Flustrella, Gray.

Flustrella hispida, Fabricius, form *cylindrica.*
(Pl. XIV. figs. 1, 1*a*.)

Zoarium erect, much branched; stem and branches cylindrical, composed of rather firm chitinous material. *Zoœcia* disposed round the cylinder in six linear series, those of the neighbouring series alternating, large, regularly ovate, convex in front; surface smooth, round the margin a large number (15–18) of tapering acuminate spines, with an enlarged base, which bend inward over the front wall, but without meeting; orifice close to the upper extremity of the cell, bordered above and below by a thin horny rib; immediately above it a few (usually three) erect spinules; numerous large spines, springing from a kind of boss, scattered over the interspaces between the cells.

Loc. Port Phillip Heads (*J. B. Wilson*).

Range. Northern and Arctic seas, Britain, France (S.W.).

This is a very remarkable form, and for some time I was quite disposed to regard it as a distinct species; but a careful examination of the cell has convinced me that in this essential element of the structure there are no characters to separate it from the common *F. hispida* of our English coasts. The difference in habit and external appearance, striking as it is, has a parallel in many other cases, and is merely varietal.

Similar diversities in the mode of growth are of frequent occurrence within the limits of a species amongst the Cheilostomata, and in the Ctenostomatous group *Alcyonidium hirsutum* is found as a gelatinous crust and as an erect palmate expansion with many lobate branches. In the present case the zoarium seems to be firmer and less fleshy than in the crustaceous condition, and is of a rather dark horn-colour. The branching is irregular; in the largest specimen I have seen the stem divides dichotomously near the base, the secondary shoots dividing into tall flexuous branches, which bear numerous short branchlets. The branches are slightly attenuated and smooth at the base. There is always much variability in the number of the spines, and in English specimens they are often very much confined to the oral region, but they are also found surrounding the cell. In the Australian variety they are few in number and small above the orifice, but form a regular line round the margin of the cell, and bend in over the front of it.

Flustrella dichotoma, v. Suhr (sp.).
(Pl. XIV. figs. 2 *a*, 2 *b*.)

Verrucularia dichotoma, v. Suhr, Ratisbon Flora (1834), p. 725, tab. i. fig. 9, *a*, *a*.
Farciminaria dichotoma, Busk, Quart. Journ. Microscop. Sc., "Zoophytology."

Zoarium erect, much branched di- and trichotomously, the terminal branchlets generally trifid; stem and branches slender, cylindrical, composed of a transparent membranous material; attains a height of about 2 inches. *Zoœcia* arranged in six series, those of neighbouring series alternating, very regularly ovate, bounded by a strongly marked dark line, very convex; surface smooth, destitute of spines, prolonged below into a kind of peduncle; orifice placed a little way below the top of the cell, bilabiate, with a dark chitinous border. Between the rows of cells a narrow smooth interspace divided at intervals by transverse dark lines (? septa).

Loc. Port Phillip, Australia (*Kirchenpauer*); Port Phillip Heads (*J. B. Wilson*).

This form, originally described by v. Suhr as a *Fucus*, was referred by Busk to his family Farciminariidæ, and placed in the genus *Farciminaria*. Owing probably to the dried condition of his specimens the latter writer has overlooked the Ctenostomatous structure of the orifice, which agrees in all respects with that of *Flustrella*. In the characters of the zoœcium and the general habit this species approaches the cylindrical form of *Flustrella hispida* just described, and must rank in the same genus.

The cells in the same longitudinal series are not in immediate contact, but are connected one with the other by a peduncular extension, which is bounded like the cell itself by a dark reddish-brown line. Nor are the cells in neighbouring rows united laterally, a narrow interspace lying between the series and extending throughout the length of the branch.

In the isolation of the cells this species differs from *F. hispida.* There is no true joint at the origin of the branches, but merely a constriction, and the zoœcia run on continuously.

This form and the preceding illustrate a very different phase of the genus *Flustrella* from that to which we have been accustomed, and show that it has a wide geographical range.

Suborder Cheilostomata.

Family **Cellulariidæ.**

Bugula, Oken.

Bugula uniserialis, n. sp. (Pl. XIII. fig. 8.)

Zoarium minute, composed of geniculate, slightly branched shoots of transparent texture and a delicate horn-colour; branches given off sparingly from about the middle of the dorsal surface of a cell. *Zoœcia* uniserial, bent alternately to opposite sides, so as to present a zigzagged appearance, each cell originating on the dorsal surface of the one beneath it, immediately below the top and directed obliquely outwards, boat-shaped, of equal width in the upper portion, slightly contracted below; aperture occupying the whole front, and closed by a transparent membrane; margin thin, running out above at each side into a sharp spinous projection; at the top of each cell a very minute articulated *avicularium*, placed just below the upper margin and usually about the middle of it, well rounded behind, with a rather long back sloping down to a well-developed beak, mounted on a rather prominent peduncle. *Oœcium* helmet-shaped, smooth and shining, placed on the side of the cell close to the top, and overhanging the orifice more or less.

Loc. Western Australia, on weed (*Miss E. Gore*).

This species is probably the minutest of its tribe (so far as known), and is very scantily branched and simple in habit.

Though the uniserial and geniculate character of the cells confers upon it a marked individuality, it is really a very typical *Bugula*, so far as all the essential elements of structure are concerned.

Family Cellariidæ.

Cellaria (part.), Lamouroux.

Cellaria fistulosa, var. *australis*, MacGillivray.
(Pl. XIV. figs. 4, 4 *a*, 4 *b*.)

Zoarium much and irregularly branched, consisting of stout, unjointed, cylindrical stems (made up of as many as ten rows of cells), often of considerable length, tapering slightly downwards, from which similar shoots are given off without regularity on all sides, originating in a horny base, which rises in all cases from the centre of a zoœcium; the whole rooted by a mass of tubular fibres. *Zoœcia* very regularly six-sided, usually truncate above and below, contiguous in the same line; of considerable depth, the walls sloping inward and minutely pitted, slightly crenate at the top; area very small, occupying the lower half of the cell; orifice central, arched above, the lower lip carried up into a very prominent mucronate projection, rounded at the top, a small denticle on each side of it; above the orifice a large circular oœcial opening. *Avicularium* in the line of the cells, placed on a transversely oblong area, suberect; mandible very wide and shallow, arched above and straight below, directed upward.

Loc. Victoria (*MacGillivray*); Port Phillip Heads (*J. B. Wilson*).

This form is described by MacGillivray as *C. fistulosa*, var. *australis*; but the differences between it and the normal *C. fistulosa* are such as to raise a doubt whether it would not more properly be ranked as a distinct species.

I am unable to say whether the peculiar habit of growth which characterizes all the specimens I have seen is constant; but if so, it is a point of considerable importance. The jointing of the stem, by which it is divided into definite segments (or internodes) in the ordinary forms of *Cellaria*, has disappeared, and with it the regular dichotomous ramification. The shoots are continuous throughout, and the branches are given off irregularly, each of them originating from the centre of one of the zoœcia, to which it is attached by a chitinous base (Pl. XIV. fig. 4 *a*).

The large size of the cylinders is also a distinctive point, for though there is considerable variability in this respect in

C. fistulosa, it never, I believe, makes any approach to the size and stoutness of habit which we find in the present form. But the most important differences are found in the cell. The orifice is placed very low down, about the centre of it; the space above it is occupied by the opening to the oœcium, which is very large and circular in form. Round the upper part of the orifice there is a kind of border, which seems to pass downward behind it.

The lower margin is elevated into a mucronate process, which more or less conceals a considerable portion of the opening, and in each corner, between it and the side walls of the orifice, is a conspicuous white denticle. The mucronate extension of the peristome is very conspicuous when the cell is viewed in profile. In *C. fistulosa* the lower margin is all but straight, and the denticles are (so far as my experience goes) wanting. The avicularium resembles in general character that of *C. fistulosa*, but it is very much wider and almost erect and has an extremely shallow mandible; the area on which it is placed is also of a different shape.

In spirit-specimens a delicate membrane is present, which covers the whole of the front of the cell (including the ovarian opening), with the exception of the oral operculum.

EXPLANATION OF THE PLATES.

Plate XIII.

Fig. 1. *Membranipora marginella*, n. sp.
Fig. 2. *Membranipora favus*, n. sp.
Fig. 3. *Microporella violacea*, Johnston, form *plagiopora*, Busk.
Fig. 4. *Lepralia robusta*, n. sp.
Fig. 5. *Porella malleolus*, n. sp.
Fig. 6. *Smittia trispinosa*, Johnston, form *bimucronata*, n.
Figs. 7, 7 *a*. *Smittia trispinosa*, Johnston, var. i.

Plate XIV.

Fig. 1. *Flustrella hispida*, Fabr., form *cylindrica*, n. 1 *a*. Nat. size.
Figs. 2, 2 *a*. *Flustrella dichotoma*, v. Suhr (sp.): zoœcia, magnified. 2 *b*. Nat. size.
Fig. 3. *Pedicellinopsis fruticosa*, n. gen. and sp.: group of polypides. 3 *a*. Nat. size (about). 3 *b*. Two polypides. 3 *c*. Portion of tube.
Fig. 4. *Cellaria fistulosa*, var. *australis*, MacGillivray: zoœcia, magnified. 4 *a*. A single cell, showing the origin of a branch. 4 *b*. Nat. size, showing the peculiar mode of branching.

XLII.—*New Coleoptera in the British Museum.* By Charles O. Waterhouse.

Dynastidæ.

Heteronychus simplex, n. sp.

Niger, bene convexus, nitidus, subtus piceus; thoracis lateribus laxe subtiliter punctulatis; elytris sat fortiter punctato-striatis, apice crebre punctato; pygidio sat fortiter punctato, medio apiceque fere lævibus; pedibus nigro-piceis, tarsis piceis, tibiarum corona apicali spinis circiter quinque instructa.

Long. 6–7 lin.

Very similar to *H. arator*, Fabr., but with fewer spines at the apex of the posterior tibiæ. Head finely rugulose. Thorax one third broader than long, parallel at the sides, arcuately narrowed in front; punctuation very fine, not very close (often obscure); the punctures at the posterior angles distinct, and at the anterior angles rather strong. Scutellum smooth. Elytra with the sutural stria strongly marked, closely punctured. Each elytron with eight lines of distinct punctures; the intervals between them nearly equal; the first line is entire; the second does not quite reach the apex; the third and fourth terminate at one quarter from the apex; the fifth and sixth lose themselves in the apical punctuation; the seventh and eighth are composed of distinct punctures near the shoulder, but posteriorly the punctures are extremely fine and the line is apt to be broken. There are generally a few punctures on the first interstice. The apex is moderately, closely, and strongly punctured. The two lines which form the stridulating-organ on the propygidium are very distinct, nearly parallel, and a little less than one millimetre apart. At the apex of the posterior tibiæ there are the usual two strong spines at the lower angle, and two long, very slender spines at the upper angle; on the outer margin there are five not very long, stout, lanceolate spines.

Hab. China (*J. C. Bowring, Esq.*).

Cetoniidæ.

Pœcilopharis unifŏrmis, n. sp.

Allied to *P. emilia*, White, but relatively a little broader. Entirely of an olivaceous-green colour, immaculate. Head finely punctured; the clypeus not impressed in the middle of the front margin, which is nearly straight. Thorax a trifle broader in front, impunctate, as well as the scutellum. Elytra with five or six lines of shallow punctures (which are open posteriorly), the lines not reaching the apex; the sides of the elytra are posteriorly marked with transverse striæ, as in *P. emilia.* The pygidium more closely striolate than in *P. emilia.* Anterior tibiæ with three acute teeth at the apex, placed close together, parallel to one another, and at right angles to the tibia. Length 10 lines.

This last character will at once distinguish it from its allies.

Hab. Santa Anna, Solomon Islands (*H. B. Guppy*).

Pœcilopharis Curtisii, n. sp.

Allied to the preceding; and, like it, of a uniform colour, except that there is a slight coppery tint in certain lights. The clypeus has a slight impression in the middle of the front margin, which is very slightly emarginate; the punctuation is closer and stronger than in *P. emilia*, and there is a mixture of extremely fine punctuation. Thorax with some excessively fine punctures above, and a few larger ones at the sides. Elytra very smooth, much flattened at the apex, with no lines of punctures, but a few excessively fine punctures may be traced here and there; the apical half of the lateral margin is transversely striolate. The pygidium is rather more strongly and decidedly more closely striolate than in *P. emilia*. The anterior tibiæ have three apical teeth, two approximate at the apex, the third slightly removed from the others. Length 10 lines.

Hab. Batchian (*C. Curtis*).

This species has the elytra less suddenly declivous at the apex than its allies.

Buprestidæ.

Chalcotænia læta, n. sp.

Valde elongata, nitida, cyanea; thorace rugoso, pallido pollinoso; elytris viridi-cyaneis, quadricostatis, interstitiis flavo-pollinosis. Long. 21 lin., lat. $7\frac{1}{2}$ lin.

Allied to *C. gigas*, but a little broader, the thorax relatively broader posteriorly. Light sky-blue above, the raised parts on the thorax darker; the whole underside very dark blue, almost black in parts. The thorax has numerous, irregular, raised smooth spots above, the intervals finely punctured. The costæ of the elytra are as in *C. gigas*, but the third one is shorter. The apex of each elytron has four or five acute teeth, but the sutural angle is scarcely more produced than the other teeth. The underside is shining, with very numerous small (generally elongate) marks, which are finely punctured, and generally filled with yellow pollen. The under flanks of the prothorax, the sides of the metasternum, the metathoracic epipleura, and the sides of the basal segment of the abdomen are not densely and finely punctured as they are in *C. gigas.*

Hab. Queensland.

Erotylidæ.

Aulacochilus humeralis, n. sp.

Ovate, very convex, shining, black. Each elytron with two large yellow spots, the basal one occupying all the shoulder, nearly touching the scutellum, but leaving the narrow reflexed lateral margin black; the spot is oblique on its inner margin and trisinuate posteriorly. The second spot is behind the middle, transverse, lunate. The head is very distinctly and moderately thickly punctured. The thorax is narrowed in front, finely but distinctly and moderately closely punctured. The sides are rather straight (as compared with allied species), the margins strongly incrassate; the incrassate margin much wider at the anterior angles; the anterior angles rather prominent. The elytra are very delicately striate-punctate, the intervals obscurely punctured. Length 4½ lines.

Hab. Pasamanca, Philippine Islands ('*Challenger*' *Exped.*).

This species is allied to *A. quadrisignatus*; but is quite black, more convex, the thorax straighter at the sides, with more incrassate lateral margins, and the humeral spot of the elytra does not leave a black spot on the callus.

British Museum, South Kensington.

XLIII.—*Remarks on the Gastræa-Theory.* By G. Bütschli *.

[Plate XV.]

In the sphere of speculation on the Metazoa as regards their developmental history and phylogenesis the explanation of the probable origin of the primitive bilamellar form has hitherto formed a principal difficulty. Hence, of course, the conception which one must form of the general morphology of this first bilamellar Metazoan form has also varied.

* Translated by W. S. Dallas, F.L.S., from the 'Morphologisches Jahrbuch' (1884), Band ix. pp. 415–427.

The most usual view, which, as is well known, Häckel first endeavoured to establish, holds this primitive form to be the so-called gastrula, or, translated into phylogenetic language, the gastræa. The conception of the phylogenetic origin of this gastræa is also conformable to this view; it was produced, as indeed may so frequently be observed ontogenetically, by the invagination of a one-layered blastula or blastosphere. The deviations from this primitive course of development of the gastrula which occur in the ontogeny of numerous Metazoa may then be explained by the assumption of secondary deviations, changes of the original course of development.

In opposition to this view different ideas were put forward, especially by Ray Lankester * and Metschnikoff †, who, notwithstanding certain differences, agreed in this, that they disputed the originality of the production of a bilamellar form by invagination, and thus endeavoured to deprive the so-called invagination-gastrula of its significance as a primitive form. In the place of this latter bilamellar form they sought to set one which also sometimes occurs in ontogeny, namely the so-called planula-form, which is destitute of a primitive mouth. Ray Lankester thought that we might regard as the most primitive that form of the planula which is furnished from the first with a central cavity; while Metschnikoff expressed himself in favour of the view that those planula-forms are the most primitive which are originally (*i. e.* after bilamellarity has been produced) solid, and only subsequently acquire an intestinal cavity by the separation of the central entodermal cell-mass. The difference in the views of the two naturalists is chiefly caused by differences in their speculative opinions as to the processes of nutrition which led to the production of a special nutritive entodermal cell-layer. But upon this point we shall hereafter have to enter more into detail.

Considering these contradictory views and the small prospect that is nowadays offered to us of attaining with our speculations to any thing really elucidatory, it might perhaps seem desirable to suppress a third view, to some extent intermediate between those above referred to. If I nevertheless venture to develop it here briefly, I may plead that it presented itself to me very unexpectedly in the course of other investigations, and that, after I had long pursued it, it

* E. Ray Lankester, "Notes on Embryology and Classification," Quart. Journ. Micr. Sci. n. s. vol. xvii.

† E. Metschnikoff, "Spongiologische Studien," Zeitschr. für wiss. Zool. Bd. xxxii., and also "Vergleich. embryol. Studien," *ibid.* Bd. xxxvi. and xxxvii.

received a sort of confirmation by a discovery which came from quite another side.

When the business is to ascertain, in a speculative fashion, the course of a phylogenetic process, it seems to me that in general a discussion of the primitiveness of the ontogenetic process is very difficult, and has little prospect of result. It appears to me, on the other hand, to be much more important that for certain stages of the assumed phylogenetic course of development there are at the present day, or have been formerly, representatives which demonstrate the possibility of the existence of these stages. Finally, it seems to me very important that the changes of the assumed forms should be readily intelligible, and occur gradually, not suddenly, and also should be really advantageous. In the last respect especially I think that the new view now to be developed possesses some advantages over its predecessors.

The starting-point of my observations was formed by the colonies of the Flagellata, for, as has already frequently been urged by myself and others, we must undoubtedly connect the derivation of the Metazoa with some such forms. I believe that in connexion with this, moreover, it is of comparatively little consequence whether the Flagellata that we adduce for comparison possess either a more animal or a more vegetable mode of nutrition, as the physiology of nutrition varies much, without reference to the morphology, in the section Flagellata. Now we certainly find among the colonies of the Flagellata not a few which in their structure represent a so-called blastula-form, as among the Volvocineæ the genera *Volvox* and *Eudorina*, and, further, especially the genus *Uroglena*, and approximately some others.

Nevertheless the difficulty of deriving a bilamellar form from such colonies appears to me to be very considerable, and so, indeed, according to either of the hypotheses previously mentioned. The assumption of the invagination of such a blastula-stage presupposes the differentiation of one half, or, at any rate, of a section of the cell-sphere. The one half would become nutritory, and therefore the entoderm, while the other would remain essentially locomotory. Even this differentiation will be difficult to bring into harmony with the presupposed spherical formation. Such a cell-vesicle, in connexion with its general uniformly rotating movement, will present little chance of the occurrence of a differentiation into two different half-spheres. Should a differentiation of two kinds of cells occur, it would certainly be much more advantageous to such an organism if the different kinds of cells were uniformly distributed intermixed over the surface of the sphere.

To this may be added further, as indeed has already been pointed out by Metschnikoff and others, that the advantages of a commencing invagination of one half into the other are not very intelligible; and in this view I also entirely agree.

Perhaps, therefore, it would be better to allow the bilamellar form to originate from the blastula-stage referred to by a process of so-called delamination, therefore in the way which Metschnikoff and Lankester regard as the more primitive. But even this view seems to present very serious difficulties. The hypothesis put forward by Lankester seems to be quite inadmissible, namely that the inner ends of the cells of the unilamellar blastula were particularly entrusted with the assimilation of the nutriment, and finally even split themselves off as independent entodermal cells. It is difficult to recognize in this an advantage to the collective body. We might say that the separated entodermal cell is deprived of its better half, *i. e.* the ectodermal part, which brought it nourishment; nay, one might really say with justice, it is deposed from its function. But to make up for this, according to Lankester's conception, a further change now occurs, that is to say, the reception of nourishment becomes concentrated upon one spot of the surface of the sphere, and the nourishment penetrates here into the intestinal cavity, at first without the existence of any mouth-opening. In the first place, this localization of the reception of nutriment would certainly be a disadvantage, and not an advantage; and further, this profound change of the whole process of reception of nourishment is supposed to take place without any visible cause, and, moreover, quite suddenly.

I think, therefore, that we cannot accept as satisfactory Lankester's hypothesis as to the origin of the bilamellar embryonal form. Metschnikoff's idea also seems to me to suffer under inherent improbabilities, in many respects corresponding with those which have been brought forward against Lankester's hypothesis. Metschnikoff supposes that individual cells out of the unilamellar cell-wall of a blastuloid primitive form wandered into the interior of the vesicle, and, indeed, especially such cells as had received nourishment particularly abundantly. This immigration, which was originally only occasional, gave rise finally to a constant accumulation, a central mass of cells, *i. e.* to the formation of an entoderm, which originally neither enclosed a central primitive intestinal cavity nor was accessible through a mouth-opening. As, however, the formation of an entoderm is inconceivable unless real advantages in nutrition thereby occur, with which, indeed, the differentiation of this germinal layer seems to be causally connected, the question is, Can we really demonstrate actual advantages for the process of nutrition, which render the immigration of the entodermal cells admissible? It seems to me, however, that the immigration of the entodermal cells, to which the reception of nourishment is confided, cannot be regarded as an advantage. Without the simultaneous formation of a mouth-opening, which, as in Lankester's hypothesis, is unintelligible and destitute of motive, the immigration of the entodermal cells would, in my opinion, have been only disadvantageous, because, if we may so speak, they would thereby have bolted themselves in.

These and similar considerations, but especially the endeavour to establish a plausible connexion between invagination and delamination, led me to the idea that probably the spherical blastula might not have been after all the starting form of the first bilamellar stages; and I believe that both ontogenetically and among fully-developed organisms stages are presented which form more satisfactory starting-points than the blastula for the bilamellar stage.

Among the colonies of the Flagellata there is a genus of Volvocineæ which is constructed upon the type of the unilamellar cell-plate, namely *Gonium*, and a very nearly allied one which occurs in the form of a unilamellar ring. When once the notion had occurred to me that bilamellarity might well have commenced in the stage of such a cell-plate, the conception seemed to me to offer the most favourable conditions for arriving at a satisfactory idea of the phylogenesis of the gastrula formation.

Accordingly it appears to me to be assumable that the bilamellar stage first occurred in a Protozoan colony, the cells of which were arranged side by side in the same plane, so as to form a one-layered plate. Then, all the cells dividing parallel to the surfaces of the plate, there was next produced a two-layered plate, of which the two layers of cells perhaps still showed no differentiation. For the sake of intelligibility, and because this has since been kept similar, we shall give his stage of the bilamellar plate the name of *placula.*

Moreover, it is easily conceivable that the two sides of a unilamellar plate might develop different functions—that the one might adapt itself chiefly for locomotion and the other for nutrition, and that, finally, in the passage into the two-layered state, these two functions may have been localized upon the two cell-layers *.

* Many reasons derivable from the structure of the Flagellata and their

We therefore take such a two-layered plate as the starting-point, and will see, in the first place, how a gastrula-like form could be developed from it. Clearly by the simple incurvation of such a placula towards the entodermal surface, and final conglobation until the formation of a blastopore. But, one naturally asks, what advantage will such an incurvation of the plate possess? Upon this point various statements may be made. The incurvation of the plate, and particularly of its entodermal layer, which is at first but slight, will enable large nutritive masses to be attacked simultaneously by a number of neighbouring cells, and at the same time the cavity of the underside will serve as a sort of trap in which prey may be captured and held fast, if the curved plate lowers itself over a prey resting upon some support. Both advantages will become more and more marked the more the curvature makes itself felt; and the disadvantage which consists in the fact that the invagination-aperture gradually diminishes in size, may be compensated by the increased security of the prey when captured, of which it is the cause.

The next question, however, is whether a course of development such as we have constructed hypothetically is anywhere ontogenetically represented, and this is actually the case. It occurs mostly in certain Nematoda, such as *Cucullanus* according to Bütschli *, and in the main also in *Rhabdonema*, according to Götte †. In these cases the result of the process of segmentation is a two-layered cell-plate, a true placula consisting of ectoderm and entoderm, which afterwards becomes incurved as above described, and passes into the gastrula-stage. Indications of the same course of development are also frequently to be seen, although usually the plate-form does not appear in such purity, seeing that between the two layers there occurs a small accumulation of fluid, *i. e.* a segmentation-cavity has been developed, which was entirely wanting in the first-mentioned cases. I will here cite a few examples which distinctly show such a plate-form:—*Lumbricus* according to Kowalevsky, *Paludina*, *Chiton*, according to Kowalevsky's investigations; further, *Sagitta*, in which the segmentation-cavity is very slightly developed; and, finally,

colonies make me regard the first-mentioned view as the more probable. Unfortunately, however, I am unable to cite any plausible advantages for the commencement of the bilamellarity of the plate, although this may perhaps have occurred simply by special conditions of growth, and at any rate one cannot see that any disadvantage could accompany the commencement of bilamellarity.

* Zeitschr. f. wiss. Zool. Band xxvi. p. 103.

† Abhandlungen zur Entwicklungsgeschichte der Thiere. Leipzig, 1882.

Phoronis and *Ascidia mentula*, according to Metschnikoff. Of course we here leave out of consideration all those cases in which the original conditions appear to be obscured by an abundant development of nutritive vitellus.

Our conception, therefore, requires that, in opposition to the ordinary pre-existing notions, we should regard the so-called blastula-stages not as palingenetic developmental forms. In this we partly agree with Lankester and Metschnikoff, both of whom regard the so-called invagination-blastula, *i. e.* the blastula which becomes converted into the bilamellar gastrula by invagination, as a cœnogenetic form.

My conception, however, also brings the so-called delamination-gastrula into the series of cœnogenetic forms; and this consequence, in general, need not be regarded as contradictory, although the important differences of the two kinds of blastospheres are just as marked from my point of view as from those of the two above-mentioned naturalists.

The production of the so-called invagination-gastrula from the bilamellar placula, which we have assumed as the primary stage, is not difficult to understand. It took place simply by accumulation of fluid between the two cell-layers, by which these were gradually more and more separated from each other and finally inflated into a spherical form, so that one half of the wall of the sphere was formed by the ectoderm and the other by the entoderm. The right to conceive of the formation of the invagination-gastrula in this fashion may be based upon the fact that all possible degrees of transition between the simple bilamellar plate and its more or less considerable spherical inflation by the development of a segmentation-cavity, occur in the ontogeny of different Metazoa.

At any rate, it is for the present just as permissible and justifiable to endeavour to derive the invagination-blastula from the bilamellar plate in the manner here indicated, as, on the contrary, to adopt the opposite course, which has hitherto been usually followed, and to regard the plate as a cœnogenetic product of metamorphosis of an original blastula. In accordance with our view, however, we must again, in this place, put the question, Could the transformation of the so-called placula into the blastula-form confer upon the developing embryo certain advantages which are of a nature to give probability to the occurrence of such a cœnogenetic process? To this I have but little to answer, and hence it appears to me that here lies a weak point of the hypothesis. However, it may be noted that the production of the spherical form may have given rise to an increased mobility of the incipient stages of development, of course under the supposition that a very early issue of the embryo from the egg-envelopes has been the rule, which, considering the process of development of the simplest living Metazoa, appears not very improbable. On the other hand, an advantage might be found in the circumstance that a blastuliform metamorphosis of the plate is favourable to any eventual nourishment of the embryo by fluid aliment introduced from without, the receptive surface being increased by the inflation into the spherical form. That such a process does occur may perhaps be indicated by the accumulation of fluid which so frequently leads to the formation of a segmentation-cavity, and which, at any rate, points to an imbibition of the cells from without.

I might here bring forward another point, namely, that the developmental history of the blastula, which we see permanently preserved in certain Volvocineæ, is by no means the same as that which we observe in the so-called invagination-blastula. Thus the blastula of the Volvocineæ does not originate by the central separation of the cells of a cell-aggregate, but by the gradual incurvation of a unilamellar cell-plate, during which, therefore, the cavity of the blastula, which only becomes closed by degrees, remains open by a sort of blastopore until the last moment of the incurvation.

I now come to say a few words of the delamination-gastrula, which, as already shown, must also, in accordance with our hypothesis, not be an original form. As a matter of course the original process which produces the bilamellarity of our placula is a process of delamination, and we have therefore at any rate to regard the delaminative production of the entoderm as original, and we may do this the more because the invaginated entoderm of the invagination-gastrula originally also separated itself from the ectodermal cells by a division (delamination). Whether this separation of the elements of the ectoderm and entoderm takes place earlier or later seems to be a matter of indifference, as indeed Ray Lankester has already sufficiently pointed out, as it is easy to understand how a separation of the two kinds of elements would occur constantly earlier and earlier, until finally even the first segmentation permanently separated the ectodermal and entodermal elements, and indeed we see this actually carried out in the interesting example of *Rhabdonema* (according to Götte). While in this way an acceleration of the separation of the two kinds of elements proves to be favourable, it certainly appears conceivable also that under certain circumstances a retardation might occur, and this might satisfactorily explain the phenomenon of the delamination-gastrula. In this case, just as we see in the *Volvox*-blastula at the present day *, a contraction of the still unilamellar cell-plate occurred before the formation of the entoderm, and the formation of the entoderm took place only subsequently within the closed blastula. The advantages of such an anticipatory sphere-formation would be the same that have been already urged in regard to the development of the invagination-blastula. But, should this conception of the delamination-gastrula prove to be correct, an essential difference from the invagination-blastula must have shown itself in the history of its production, or been able to show itself, as it is conceivable that this difference may be cancelled by secondary variations. While the invagination-blastula is formed by the separation or divergence of the segmentation-cells (Pl. XV. figs. 2 *a*, 3 *a*, 3 *b*), the delamination-blastula must, on the contrary, have originated by a process of incurvation like that which leads to the formation of the blastula of *Volvox* (Pl. XV. figs. 1*a*–1*d*). The materials at my command upon the history of the formation of the delamination-blastula furnish no certain data for the settlement of this question, but at the same time they are not adverse to our conception. From the representation that Fol † gives of the production of the delamination-gastrula of the Geryonida, our conception may perhaps obtain some support; at least, in his fig. 5 Fol represents a 16-celled stage, which closely agrees with the corresponding stage of *Volvox*. Although the figure does not show this quite certainly, it nevertheless seems to be pretty well indicated that the four cells of the inferior surface do not close together, and therefore the already existent blastula-cavity still communicates through an inferior aperture with the outer world, just as in *Volvox*. In general, however, little attention has hitherto been paid to this not unimportant question in the formation of the blastula.

As a matter of detail we have still the question, which state of the delamination-gastrula are we to regard as the more primitive, that with an original primitive intestinal cavity or that with a solid entodermal mass, the so-called "parenchymula" of Metschnikoff? In accordance with the hypothesis to which we have hitherto adhered, we must, with Lankester,

* On the development of this see Goroshankin, "Genesis im Typus der palmellenartigen Algen," in Mitth. d. k. k. rüss. Ges. naturf. Freunde zu Moskau, Bd. xvi. (in Russian), and Kirchner, "Zur Entwicklungsgeschichte von *Volvox minor*" in Cohn's Beitr. zur Biologie der Pflanzen, Bd. iii. A connected exposition of the reproduction and developmental phenomena of the Volvocineæ and their allies will be found in the next section, on the Flagellata, in my Protozoa.

† Jenaische Zeitschrift, Bd. vii. p. 471, Taf. xxiv.

although upon other grounds, decide in favour of the primitiveness of the first form. We come to this decision the more readily because we have already indicated that the so-called parenchymula appears to us, as a primitive form, to offer great difficulties as regards its explanation.

We must not close this discussion without pointing out that, in considering these circumstances, we have purposely laid no stress upon the ontogeny of the Sponges. In this respect my ideas are directly the reverse of those of Metschnikoff, to whom the ontogeny of the Sponges appears to be especially favourable to his parenchymula theory. As I am of opinion that the group of the Sponges is completely shut off from the rest of the Metazoa, proceeding quite independently from the section Choanoflagellata (Savile Kent), it appears to me incorrect to bring this group into consideration in the explanation of the phylogenesis of the other Metazoa.

Finally there still remains for discussion one circumstance which may perhaps give essential support to our hypothesis, namely, the quite recent discovery of an organism which in many respects fulfils the requirements which we must lay upon the hypothetical, tabuliform, bilamellar primitive stage, our placula.

This organism is the singular marine *Trichoplax adhærens* lately described by F. E. Schulze*. Although the life-history and especially the reproduction of this form are not thoroughly elucidated, it nevertheless appears certain to me, as well as to Schulze, that it is a mature, fully-developed form, and not a larva. This *Trichoplax*, then, would in every respect form a representative of our placula, if it had not already made an advance towards a higher development, inasmuch as it forms, not a bilamellar, but a trilamellar plate. Between the entoderm, occupying the lower surface, which resembles a cylinder-epithelium, and the thin flat-celled ectoderm covering the upper surface, there is interposed a connective-like layer, no doubt proceeding from the entoderm, and which is comparable to a mesoderm. For my part, I regard the comparability of the tissue-layers of this *Trichoplax* with the germinal layers of the Metazoa, already indicated by F. E. Schulze, as exceedingly probable, except as regards a direct homology of the intermediate so-called mesoderm, which is rather to be esteemed an independent analogous formation.

However, I regard it as very probable that *Trichoplax adhærens* forms one of those transitional forms towards the higher Metazoa, constructed in accordance with the gastrula-

* Zool. Anzeiger, Jahrg. vi. no. 132 (1883), p. 92.

plan, such as we might expect to meet with upon the above-stated hypothesis.

As I had formulated the outlines of the hypothesis before the publication of Schulze's discovery, I was surprised to find in the latter, in a certain degree, such unexpected confirmation of purely speculative considerations. Although, therefore, the present hypothesis is not based upon the interesting *Trichoplax*, nevertheless the latter has furnished the inducement to publish the speculation. I am, indeed, not convinced that our science will derive any direct gain from the pursuit of such speculative endeavours, but perhaps they may furnish some incitement to a more accurate investigation of the ontogenetic history of the formation of the blastulæ and gastrulæ, by means of which the most probable hypothesis, *i.e.* the one which is at once freest from contradictions and most explanatory, will finally obtain the victory.

EXPLANATION OF PLATE XV.

On the accompanying Plate I have endeavoured, by means of a few diagrams, to elucidate the ideas developed in the preceding pages as to the reference of the different forms of blastulæ and gastrulæ to a common starting-point. That process which I regard as the most primitive is represented in figs. 1 *a*–2 *a–d*. Fig. 1, binary division; fig. 2 *a*, eight-celled stage: by an equatoreal segmentation the (tinted) entodermal elements have separated from the (white) ectodermal elements. Of course, under certain circumstances this separation may take place either earlier or later. Fig. 2 *b*, section. The ectodermal and entodermal cells have increased and now form a very distinct placula. In fig. 2 *c* this commences its curvature towards the entodermal surface; and this leads, finally, as in fig. 2 *d*, to complete invagination of the entoderm.

Figs. 1 *a*, 2 *a*, 3 *a*–3 *c* show the development of the so-called invagination-blastula. The further development of the stage fig. 2 *a* is altered in this way: the severed ecto- and entodermal cells are separated from each other by the development of a segmentation-cavity (fig. 3 *a*), and finally lead to the blastula. This, of course, consists of two different parts—an ectodermal and an entodermal section. It is particularly to be noted, however, that the relative size of these two sections appears to be very different in the different invagination-blastulæ, which may be referred to an earlier or later severance of the ecto- and entodermal elements, as well as to the relative quantities of these two elements. The stage fig. 3 *b* passes finally, in the well-known manner, by invagination (fig. 3 *c*) into the gastrula-stage.

Figs. 1 *a*–1 *e* represent the delamination-blastula. Fig. 1 *a*, binary division. Fig. 1 *b*, eight-celled stage, but with only four cells drawn in side view. Even in the four-celled stage the tendency towards incurvation will be expressed, leading to a change of position in the cells, so that these now direct their entodermal parts axially. At the same time it may happen that the groove which effects the transition from the four- to the eight-celled stage runs nearly or quite equatoreally, namely, if a change of position of the first four segmentation-spheres round a right angle has occurred. By further divisions, all of which really run parallel to one another and appear to be radially directed towards the centre of the embryo only in consequence of the continued incurvation, the stage fig. 1 *c* (section) is produced; this already shows a distinct cavity, which, however, is still open at the inferior surface. Finally, this stage passes, in an easily intelligible manner, by further increase of cells and final closure, into the blastula, which, according to our view, originates in accordance with the blastula of the Volvocineæ. All the cells of this blastula are still composed of the two elements, the ecto- and entodermal parts, which are now severed by an equatoreal groove dividing each cell into an external and internal portion (fig. 1 *e*). The cutting off of the entodermal portions of the delamination-blastula appears not always to proceed so uniformly as is here represented in accordance with the process demonstrated in the Geryonida by Fol and Metschnikoff. At least the representation that Kowalevsky gives of the delamination in *Encope* seems to indicate that the division sometimes takes place successively, and thus the central cavity of the blastula is gradually filled with the entodermal cell-material. That here perfectly solid entodermal contents are first of all produced, in which an archenteric cavity only subsequently makes its appearance, may certainly be regarded as a secondary variation. The Siphonopora, however, present another variation of the delamination-blastula, as in them the development of a blastula-cavity is suppressed, and an archenteric cavity is only subsequently developed in the entodermal cell-mass. The reference of this modification to the mode in the Geryonida, which I regard as the original mode, appears to present no particular difficulties.

XLIV.—*On Mesozoic Dicotyledons.* By Lester F. Ward*.

In the following remarks on Mesozoic Dicotyledons, I confine the term *Dicotyledons* to that subclass of the vegetable kingdom which is embraced under the term *Angiosperms* in most modern text-books of botany. This is the usage of most vegetable palæontologists †, and the reasons of adopting it have been frequently stated‡.

The Dicotyledons occupy somewhat the same position in the history and development of plants that the Mammalia occupy with respect to animals. They constitute the dominant type, and in their rapid march have now so completely

* From the 'American Journal of Science,' April 1884, pp. 292–303.

† Göppert, Geinitz, and one or two others conform to the Jussiæan system.

‡ See the 'American Naturalist,' vol. xii. (June 1878), pp. 359–378.

gained the ascendant as to dwarf all other forms into relative insignificance. They include nearly all the deciduous forest trees, the shrubby undergrowth, the leafy herbage, and the weeds of all temperate regions.

But this has not always been the case. In fact the reign of the Dicotyledons, geologically considered, has been very brief. Although there is evidence that the earth has been covered with vegetation since the beginning of the Carboniferous age at least, still there is nothing to warrant us in saying that a single dicotyledonous plant existed prior to the close of the Jurassic. Indeed, we do not know from the actual discovery of specimens that this type appeared earlier than the second recognized group of the Cretaceous—the Urgonian. Until quite recently the presence of these plants in formations lower than the Miocene was so rare that it was with the Tertiary rather than with the Cretaceous that the existing dominant vegetation of the globe was assumed to have originated.

Notwithstanding this, some of the earliest, if not the very earliest, discoveries of these forms were in Cretaceous strata. In the stone-quarries of the Harz Mountains near Blankenburg, were found, near the beginning of the eighteenth century, prints of large leaves which the workmen believed to be those of the grape-vine, and which were mentioned by Scheuchzer, Brückmann, and Walch, but without any attempt at their scientific determination.

A brief historical review of the discovery, identification, and publication of dicotyledonous species in Cretaceous strata of Europe and America, including the arctic regions, will show the importance which this subject is assuming among palæontologists.

In 1833 Zenker* took up in earnest the study of the Blankenburg leaf-prints, and described, figured, and named five species belonging to two genera. One of these genera he rightly concluded to have no living representatives, and he therefore named it *Credneria*, after his friend Prof. Credner, who collected the specimens.

In 1841 Göppert† figured a number of dicotyledonous leaves from the Quadersandstein of Silesia, but did not venture to give names to them.

* 'Beiträge zur Naturgeschichte der Urwelt,' von Jonathan Carl Zenker. Jena, 1833.

† 'Ueber die fossile Flora der Quadersandsteinformation in Schlesien,' c., in Nova Acta Acad. Naturæ Curiosorum, vol. xix. Taf. xlvii., li., liii.

The next year Geinitz* identified three species in the lower Quader of Saxony at Niederschöna, the fossil flora of which place was so well worked up by Ettingshausen in 1867.

In 1845 Corda† figured some dozen leaves from Trziblitz, Luschitz, Perutz, and Weberschan, in Bohemia, some of which localities he placed in the Gault, but they are probably all in the Lower Quadersandstein, or Cenomanian. He made no attempt to refer these forms to genera and species.

Unger's 'Synopsis' ‡ appeared the same year, in which sixteen species of Cretaceous Dicotyledons are recognized down to that date. Göppert§, however, admitted only thirteen species in his table published in Bronn's 'Naturgeschichte,' which also appeared in 1845.

Debey||, in 1848, enumerates sixteen species as previously published, and adds to these twenty-seven others from the neighbourhood of Aix-la-Chapelle, most of which, however, he contents himself with calling *Phyllites*; and as no figures were made, it is possible that some of these were not Dicotyledons. He also gives four *Carpolithes* which he identifies with dicotyledonous orders.

The same year Göppert¶ published a supplement to his Flora of the Quadersandstein, in which a number of Dicotyledons are recognized.

In Ettingshausen's 'Proteaceen der Vorwelt,' 1851**, four Cretaceous species are enumerated, and Von Otto†† in his 'Additamente,' 1852–54, also described Proteaceæ from the Quader of Saxony; while Miquel‡‡, in 1853, described a few Dicotyledons from the Upper Cretaceous of Limburg.

* 'Characteristik der Schichten und Petrefacten des sächsisch-böhmischen Kreidegebirges,' von Dr. Hans Bruno Geinitz. Heft 3, Dresden and Leipzig, 1842, p. 97.

† In: 'Die Versteinerungen der böhmischen Kreideformation,' von Aug. Em. Reuss. Stuttgart, 1845–46, Taf. l., li.

‡ 'Synopsis plantarum fossilium' autore Fr. Unger, M.Dr., Lipsiæ, 1845

§ 'Naturgeschichte der drei Reiche,' vol. xv. 2 ('Handbuch einer Geschichte der Natur,' iii. 2), von Heinrich G. Bronn. Stuttgart, 1849, pp. 44–57, 66.

|| 'Uebersicht der urweltlichen Pflanzen des Kreidegebirges überhaupt und der Aachener Kreideschichten insbesondere,' von Dr. M. Debey, in 'Verhandlungen des naturhistorischen Vereines der preussischen Rheinlande,' 5. Jahrgang, 1848, p. 113.

¶ 'Zur Flora des Quadersandsteins,' in Nova Acta Acad. Nat. Cur. xxii. 1, p. 365.

** 'Sitzungsberichte der mathem.-naturw. Classe der kaiserlichen Academie der Wissenschaften, Wien,' Bd. vii. Heft iv. 1851, p. 711.

†† 'Additamente zur Flora des Quadergebirges in Sachsen,' von Ernst von Otto, Heft ii. Leipzig, 1854, p. 44.

‡‡ 'De fossile planten van het Krijt in het hertogdom Limburg,' Haarlem, 1853; Verhandl. Geol. Kaart Nederl. i. pp. 33–56.

In 1856 Dunker* described and figured in the 'Palæontographica' four species from Blankenburg in addition to those of Zenker, and one cluster of fruit which he believed to belong to *Credneria*, and to indicate strongly that those ancient plants belonged to the Polygonaceæ. Zenker had divined that they might be amarantaceous.

One year later Stiehler† reviewed in the 'Palæontographica' the whole subject of the Cretaceous flora of the Harz Mountains, and added to all previous results the discoveries made by Hampe, a druggist of Blankenburg, in the marls near that place. Out of the numerous forms of *Credneria* he carves a new genus which he calls *Ettingshausenia*, and of which he makes eight species. He admits seven species of *Credneria*, and figures several others which he calls new species, but without assigning specific names to them.

Thus far America had contributed nothing to the flora of the Cretaceous, but in 1858 Heer described, in the proceedings of the Academy of Natural Sciences of Philadelphia‡, eight species of Dicotyledons which had been collected by Dr. Hayden in Kansas and Nebraska. These, however, he erroneously believed to be Miocene.

The next year Mr. Lesquereux § contributed a paper to this Journal, in which a number of fossil plants from Nanaimo, Vancouver's Island, and from Bellingham Bay were described as Miocene. It is now known that Nanaimo is Cretaceous, and his paper enumerates six species of Dicotyledons from that locality.

Nothing further appears to have been done until 1863, when Dr. Newberry ‖ reported, in the 'Boston Journal of Natural History,' upon certain fossil plants from Orcas Island, British Columbia, collected by the North-west Boundary Commission. He declared the horizon Cretaceous, and among the plants described were four Dicotyledons.

* "Ueber mehrere Pflanzenreste aus dem Quadersandsteine von Blankenburg," von Wilhelm Dunker. Palæontographica, iv. 1856, pp. 179–183, tab. xxxii.–xxxv.

† "Beiträge zur Kenntniss der vorweltlichen Flora des Kreidegebirges im Harze," von August Wilhelm Stiehler. Palæontographica, v. pp. 45–80, Taf. ix.–xv.

‡ "Fossil Plants of the Lower Cretaceous beds of Kansas and Nebraska," by Oswald Heer, Proc. Acad. Nat. Sci. Phil. 1858, pp. 265, 266.

§ "On some Fossil Plants of recent Formations," by L. Lesquereux, Amer. Journ. Sci. 2, xxvii. 1859, pp. 359–366.

‖ "Descriptions of Fossil Plants collected by Mr. George Gibbs, Geologist to the U. S. North-west Boundary Commission under Mr. Archibald Campbell, U. S. Commissioner," by J. S. Newberry, Boston Journ. Nat. Hist. vii. 1863, pp. 506–524.

In 1866 appeared the somewhat famous "*Phyllites* crétacées du Nebraska" of Capellini and Heer*, the latter of whom determined the fossil plants which the former had himself helped to collect at Blackbird Hill, Nebraska, in the now well-known Dakota group. The Cretaceous character of these fossils was here rather grudgingly conceded, and has never since been seriously doubted.

While America had been thus coming forward Europe had remained in the background for about ten years, or since Stiehler's monograph of the Harz in 1857. It was not till 1867 that Ettingshausen † published in the 'Sitzungsberichte' of the Vienna Academy his valuable paper on the fossil flora of Niederschöna in Saxony. The horizon of this place is considerably lower than that of Blankenburg, and belongs at the base of the Quadersandstein formation of Germany. Nevertheless, the species nearly all belong to living genera—*Quercus*, *Fagus*, *Ficus*, *Laurus*, *Protea*, &c. Twenty-eight species are enumerated.

In the same volume Unger ‡ described and figured four Dicotyledons, thus far unknown, from the Gosau (Upper Senonian) of Austria, at St. Wolfgang and Neue Welt. Though contenting himself with calling them all *Phyllites*, he yet ventured to assign two of them to the Magnoliaceæ and two to the Proteaceæ.

Returning to America, we find in 1868 the two most important contributions yet made in this country to the Cretaceous flora of the west. These were Dr. Newberry's "Notes on the later extinct floras of North America," published in the 'Annals of the New York Lyceum of Natural History' (April) §, and Mr. Lesquereux's paper in this Journal ‖ for July of the same year. Though prepared quite independently of each other, these two papers followed the same method and reached the same results. Both authors give lists of the American Cretaceous species known up to that date, Dr. Newberry enumerating 20 and Mr. Lesquereux 21 Dicotyledons.

* Verhandl. d. schweiz. Gesellsch. d. Naturf. Zürich, 1866.

† "Die Kreideflora von Niederschöna in Sachsen, ein Beitrag zur Kenntniss der ältesten Dicotyledonengewächse," von Const. Freih. v. Ettingshausen. Sitzb. lv. Abth. 1, pp. 235–264, Taf. i.–iii.

‡ "Kreidepflanzen aus Oesterreich," von Dr. F. Unger, *l. c.* pp. 642–654, Taf. i., ii.

§ The figures corresponding in the main to the species here described were published in separate form by the U.S. G. and G. Survey of the Territories, F. V. Hayden, Geologist-in-charge, under the title "Illustrations of Cretaceous and Tertiary Plants of the Western Territories of the United States," which did not appear until 1878.

‖ "On some Cretaceous Fossil Plants from Nebraska," by L. Lesquereux. Am. Journ. Sci. 2, xlvi. 1868, pp. 91–105.

The number of species described by Dr. Newberry as new was 45, and the number by Mr. Lesquereux was 47. Nine species from Fort Ellsworth, Kansas, included in Mr. Lesquereux's list, the descriptions of which did not appear until the following year *, do not enter into the figures above given. It will thus be seen that about 75 species of Dicotyledons had been described from the Dakota Group and other American Cretaceous strata down to the year 1869.

Far less could be said for Europe at this date. Hosius †, in 1869, was able to enumerate in his 'Geognosie Westfalens' twenty-five characteristic species of the Quadersandstein, which had been described and figured either by Von der Marck ‡ or by himself §. In this year, too, Heer ‖ published his 'Fossil Flora of Moletein in Moravia,' which belongs to the Lower Quadersandstein, or base of the Cenomanian. Twelve species are described and carefully figured.

In Hayden's annual reports of the geological survey of the Territories for 1870 and 1871 ¶, Lesquereux continues to enlarge the list of American species; and in 1872, Heer **, in his "Fossil Flora of Quedlinburg," makes further additions to that of Europe.

We are thus brought down to the year 1874, which is marked by three very important publications.

Schimper's 'Traité de Paléontologie Végétale' was completed in that year, and in its fourth volume †† 109 species of Cretaceous Dicotyledons are recognized. Of these 46 are American, which shows that the author was far behind in the literature of the subject. He also expresses serious doubts as to the Cretaceous age of these plants, although this had been long settled here beyond a peradventure.

Next should be mentioned Heer's "Kreideflora der arc-

* "On Fossil Leaves from Fort Ellsworth, Nebraska," Transactions of the American Philosophical Society, Philadelphia, vol. xiii. new series, pp. 430–433, pl. xxiii.

† "Die in der westfälischen Kreideformation vorkommenden Pflanzenreste" (Beiträge zur Geognosie Westfalens), von A. Hosius. Münster, 1869.

‡ "Fossile . . . . Pflanzen aus dem Plattenkalk von Sendenhorst," Palæontographica, xi. 1865.

§ "Ueber einige Dicotyledonen der westfälischen Kreideformation," Palæontographica, xvii. 2, pp. 89–104, Taf. xii.–xvii.

‖ Beiträge zur Kreideflora. I. Flora von Moletein in Mähren. Zurich, 1869.

¶ "On the Fossil Plants of the Cretaceous and Tertiary Formations of Kansas and Nebraska," Ann. Rep. 1870, p. 370. "Fossil Flora, Cretaceous Strata, Kansas," Ann. Rep. 1871, p. 301.

** Beiträge zur Kreideflora. II. Zur Kreideflora von Quedlinburg.

†† Pp. 677–679.

tischen Zone," which appeared in 1874 in volume iii. of his 'Flora Fossilis Arctica.' In this work he describes one solitary dicotyledonous species (*Populus primæva*) in the schists of Kome—Urgonian—by far the most ancient form thus far met with, and 33 species in the higher strata of Atane, which are now generally believed to correspond with the Cenomanian of Europe. These researches of Heer appeared too late to be embodied in Schimper's great work.

Finally, as crowning this fruitful year's labour, appeared Mr. Lesquereux's important quarto volume on the Cretaceous Flora of the Western Territories *, reviewing the results of all previous researches in this country, and describing and illustrating 107 species of American Cretaceous Dicotyledons. In Hayden's annual report for the same year † 26 species are described and some figured, but most of these were also more fully treated in the 'Cretaceous Flora.'

During the succeeding six years little activity was manifested in this field, the attention of palæobotanists being principally directed to the floras of later formations; but in 1880 Hosius and Von der Marck published, in the 'Palæontographica' ‡, their "Flora der westfälischen Kreideformation," an important work reviewing the entire Cretaceous flora of Westphalia. Although fossil plants have been found throughout almost the entire Cretaceous series as there represented, still it was only in the Senonian that any Dicotyledons were detected. At two quite distinct horizons within the Senonian such plants were found, 37 species being credited to the Upper and 24 to the Lower Senonian, or 61 species.

Quite an important paper by Dr. Debey appeared in 1881 §, describing certain very interesting querciform leaves from the sands of Aix-la-Chapelle. Fifteen species are described and well illustrated, all of which are referred to *Dryophyllum*, a genus founded long ago by Debey on unpublished material, and to which Saporta refers four of the forms from the travertines of Sézanne. It had been announced ‖ that Debey had collected in the vicinity of Aix-la-Chapelle no less than two

* "Contributions to the Fossil Flora of the Western Territories, Part 1. The Cretaceous Flora." By L. Lesquereux, being Report of the U. S. Geological Survey of the Territories, F. V. Hayden, Geologist-in-charge, vol. vi. Washington, 1874.

† Pp. 271–365, pls. i.–viii.

‡ Vol. xxvi. 1880.

§ "Sur les feuilles querciformes des sables d'Aix-la-Chapelle," par M. Debey. Bruxelles, 1881. (Compte rendu du Congrès de botanique et d'horticulture, 1880.)

‖ Schimper, 'Traité de Paléontologie Végétale' (Paris, 1869–1874), tome iii. pp. 671, 673.

hundred species of dicotyledonous plants; and it is to be hoped that this paper may form a beginning, at least, of the much-needed work of acquainting vegetable palæontologists with the nature of this remarkable flora.

The sixth volume of Heer's 'Flora Fossilis Arctica' appeared in 1882. In this the Cretaceous flora of Kome and Atane are reviewed with fresh materials. While unable to find any companions for the solitary *Populus* of Kome, he adds largely to the dicotyledonous flora of Atane. From 33 species in 1874 this flora now rises to 95. In the seventh volume of the same work, which unfortunately must now be the last, a new Cretaceous flora is announced, that of Patoot, also in Greenland, which is regarded as extreme Upper Cretaceous. Dicotyledons here abound; and no less than 74 species are made known in Heer's work.

Within the past few months an important paper has been contributed to the Royal Society of Canada by Principal Dawson *, in which 30 species, mostly new, from two distinct horizons of the Cretaceous of British Columbia, are described and figured.

Lastly, I am able to add to this enumeration one of the most important works that has ever been produced on vegetable palæontology, but which is still unpublished, though now ready for the press. I refer to Mr. Lesquereux's 'Cretaceous and Tertiary Floras,' which is to form the eighth volume of the series of quartos of the U.S. Geological Survey of the Territories in charge of Dr. F. V. Hayden. In this work the author again exhaustively reviews the entire subject of the American Cretaceous flora, and we find the number of Dicotyledons thus far yielded by the Dakota Group to have reached 167. In his table of distribution he attempts to embrace the flora of the entire Cenomanian Formation, to which he doubtless rightly believes our Dakota Group to belong. The total number of Dicotyledons thus marshalled is 312. Large as these figures seem, there is much reason to believe that they fall in both cases considerably below the actual state of science at the present time, as will be seen by the tabular statement given below.

If we now turn from this strictly chronological enumeration to a consideration of the stratigraphical position in which these plants have been found, as indicating their relative age, we shall find the results no less interesting than is the history of their discovery.

The various countries of the globe where geology is studied

* 'Transactions,' pp. 15–34, pls. i.–viii.

have adopted divisions for their geological formations corresponding to the character of the rocks in each country. These divisions cannot be made to harmonize with exactness when it is sought to compare widely separated regions. The attempt here made to correlate the subdivisions of the European, Arctic, and North-American Cretaceous can therefore at best only lay claim to approximate accuracy.

The Quadersandstein of Germany, in which the greater part of the European fossil plants have been found, is an extensive formation, reaching in Saxony and Bohemia from the Lower Cenomanian to the White Chalk, or Upper Senonian. Its middle portion is occupied by the Pläner sandstone and Pläner marls, which extend downward into the Upper Cenomanian and upward to the base of the Senonian. The somewhat local character and indefinite boundaries of the Quader formations have rendered it customary on the Continent, even with German geologists, to adopt the system of D'Orbigny as now modified, and to speak of the Cenomanian, Turonian, and Senonian instead of Lower Quader, Pläner, and Upper Quader; and it is also now common to apply these terms to formations in other parts of the world which are supposed to occupy the same stratigraphical positions.

The leading European localities from which Cretaceous Dicotyledons have been collected are—Saxony (Niederschöna), Moravia (Moletein), Bohemia (Trziblitz, Perutz), Silesia (Oppeln, Tiefenfurth), the Harz district (Blankenburg, Quedlinburg), Westphalia (Legden, Sendenhorst), and the vicinity of Aix-la-Chapelle. The first four of these localities belong to the Lower Quadersandstein, or Cenomanian, that of Niederschöna lying near its base. The Cretaceous of the Harz district is probably Lower Senonian. In Westphalia, Hosius and Von der Marck find fossil Dicotyledons at two different horizons, both of which, however, they place in the Senonian. The region about Legden, Ahaus, Haltern, &c. is regarded as Lower Senonian, while Sendenhorst, Haldem, &c. are said to be Upper Senonian. The iron-sand near Aix-la-Chapelle is probably still higher, and occupies the extreme Upper Senonian.

The next greatest source, outside of the United States, of the class of fossils under consideration is Greenland. The Kome beds, as already remarked, are distinctly fixed in the Urgonian, which is Lower Cretaceous, and lies between the Neocomian and the Gault. The discovery of a dicotyledonous plant at this horizon is one of the most interesting facts of palæontological science. The beds of Atane, where the greater part of the species were found, although called

Upper Cretaceous by Heer, are admitted by him to exhibit in their fossil remains so close a relationship with the American Dakota Group as to render it probable that they are of the same age. Patoot, on the other hand, is set down as extreme Upper Cretaceous; and Heer says that its invertebrate fauna indicates its identity with the Fox Hills of our Western Territories.

The localities in British Columbia from which Cretaceous Dicotyledons have come are all regarded by the Canadian geologists as Upper Cretaceous. The inland portions, situated on the Pine and Peace rivers, are said by Dr. Dawson to correspond to the Niobrara of the north-western United States, which he also correlates with the Lower Senonian of Europe. Vancouver's Island and the localities on the Pacific coast are higher, and are placed in the Upper Senonian, though he does not correlate them with any of the groups of American geologists. Fossil plants were found on the Bow and Belly river, which is said to agree with the Pierre Group; but the dicotyledonous remains appear to have been indistinct and undeterminable.

With the exception of the Dakota Group, which is commonly regarded as Cenomanian, and in which such a profusion of dicotyledonous vegetation is imbedded, no fossil plants have thus far been described from the Cretaceous of the Western Territories. Nevertheless, I have myself collected and brought to Washington during the past season some dicotyledonous leaves from a locality on the Upper Missouri river some seven miles below Coal Banks, whose position is fixed with certainty in the Fort Pierre Group, No. 4 of Meek and Hayden, which Dr. C. A. White regards as merely forming the lower portion of the Fox Hills. The material thus obtained, though meagre and fragmentary, is sufficient to render it quite certain that we here have forms nearly allied to *Platanus latiloba* of Newberry (*Sassafras mirabile*, Lesqx.), and perhaps connecting this with *Platanus nobilis*, Newb., from the Laramie strata that overlie these beds, as well as forms resembling *Quercus salicifolia*, Newb., and other Cretaceous genera and species. There is therefore ground for hoping that when this and other similar localities are thoroughly studied a new Cretaceous flora may come to light in the North-west.

I have in this paper intentionally omitted all consideration of the great Laramie Group, although this is regarded by many as Cretaceous. This is because it seems at least to be more recent than any of the European, Arctic, or British-American plant-bearing beds, while its abundant flora consists in large part of types represented in the Miocene of Europe.

It thus appears that throughout both hemispheres the conditions required for the preservation of vegetable remains in Cretaceous time have existed in a marked degree during two epochs only, the Cenomanian and the Senonian, separated from each other by a period, perhaps equal to either, during which marine forms of animal life are chiefly found. A few Dicotyledons only occur in the Turonian of Europe, as e. g. *Magnolia telonnensis* from Toulon, while the Colorado Group (Fort Benton, Niobrara) of our Western Territories has thus far proved destitute of plant life.

If now we take up the several subdivisions of the Cretaceous formation in their stratigraphical order, beginning with the lowest, we shall see that in the Neocomian, or lowest member, no plant-remains of the subclass we have been studying have as yet ever been detected *.

In the Urgonian, or next higher group, one species, *Populus primæva*, Heer, has been collected at Pattorfik, in Greenland. In volume vi. of his ‘Flora Fossilis Arctica,’ which appeared in 1882 (or eight years subsequent to the original description of this plant), Heer continued to adhere to this species as well as to its anomalous stratigraphical position.

The Gault, like the Neocomian, has thus far furnished no Dicotyledons, though not always destitute of plant-remains †.

It is with the Cenomanian that there seems to have burst in upon the world a great and luxuriant dicotyledonous vegetation. It is found alike in Saxony, Bohemia, Silesia, in Greenland, and in the western United States. Upwards of three hundred and fifty species, representing all three of the divisions of the subclass (Apetalæ, Polypetalæ, Gamopetalæ), and consisting chiefly of living genera, have been described.

It was formerly supposed that the beds at Blankenburg occupied a much lower position than that to which I have assigned them, and such as would place them in the Turonian at least, if not in the Cenomanian; and Mr. Lesquereux, in the large and important work which is about to appear ‡,

* The supposed Neocomian Dicotyledons of Russia (Eichwald, ‘Lethæa Rossica,’ ii. pp. 58 *et seq.*) are shown by Heer (Fl. Ross. Arct. iii. Theil 2, S. 26) to come from the Lower Senonian corresponding to the Harz district.

† Heer assigns the plant-beds of Spitzbergen to the Gault (*l. c.* S. 24), and Coemans finds nine new species of fossil plants in the Cretaceous of Hainaut (Mém. de l'Acad. Royale de Belgique, xxxvi., 1867), which Briart and Cornet (*l. c.* xxxiii. p. 46) placed in the Gault.

‡ "Cretaceous and Tertiary Floras," Report of the U.S. Geol. Survey of the Territories, vol. viii. (Washington, 1883).

includes the species of Heer's Quedlinburg flora in his table of distribution of the Cenomanian. It is now quite certain, however, that the Cretaceous of the Harz district is much higher, and authorities seem to agree in placing it in the Lower Senonian. On the other hand, the upper boundaries of the Cenomanian in France and elsewhere are somewhat imperfectly established. For this and other reasons I have felt justified in relegating the few species that have been classed as Turonian to the Cenomanian, of which great group they seem to be but straggling outliers.

In the Senonian, both in Europe and in British Columbia, two quite distinct horizons for fossil plants seem to occur, separated from each other by a considerable interval. In view of this I have attempted to divide this group into two horizons, and am thus able to show the Lower and Upper Senonian separately. From the Lower Senonian we have about eighty species and from the Upper about one hundred and eighty.

The following Table exhibits the number of dicotyledonous species thus far recognized in each of the groups of the Cretaceous for the four principal geographical areas within which they have been collected :—

Cretaceous Dicotyledons.

Geological Position.	Europe.	Greenland.	British America.	United States.	Total.
Upper Senonian	81	74	24	..	179
Lower Senonian	67	..	14	..	81
Turonian	..	..	..	..	..
Cenomanian }	53	114	..	.. }	351
Dakota Group }	..	..	..	184 }	
Gault	..	..	..	..	..
Urgonian	..	1	..	..	1
Neocomian	..	..	..	..	..
Total......	201	189	38	184	612

As all the plants with which we are here concerned are found in the Cretaceous, some may be surprised that this paper should have been entitled *Mesozoic* rather than *Creta-*

ceous Dicotyledons. The reason for the title chosen is simply that it may tend somewhat to enlarge the view of the true history and age of this great type of vegetation. When we see that more than three hundred and fifty species of fully developed Dicotyledons, implying the existence of many more, were flourishing in all their present luxuriance in the Middle Cretaceous, and that even in the Lower Cretaceous one species is known to have existed belonging to a genus that still survives, we cannot, if we would, repress the thought that the ancestors of these forms must have come down through older periods of the Mesozoic.

That we shall ever discover the true progenitors of the known Dicotyledons it is, of course, impossible to say; but that they had progenitors science no more hesitates to assume than any one would hesitate to assume that a foundling child must have had parents. Moreover, such is the slow and secular character of the development of living forms on the globe, that no one would suppose it possible for so prominent a group of plants as were the Dicotyledons in the Cenomanian age to have attained that condition in any thing short of a vast geologic period.

It is to be hoped that we are at last approaching the beginning at least of a solution of this truly great problem of the origin of the Dicotyledons. I have myself seen at least one slight, it may be, but very interesting sign of possible progress in this direction. Certain very defective, but very instructive, specimens collected in the Upper Jurassic of Virginia by Professor Wm. M. Fontaine, and which he kindly brought to Washington for my inspection, certainly possess all the essential elements of dicotyledonous leaves, although at the same time bearing a certain recognizable stamp of the cryptogamic and gymnospermous vegetation that characterizes that earlier age. What is to be the final verdict of science upon these forms cannot now be told; but it is to be hoped that the Mesozoic strata, not only in Virginia, but in all parts of the world, may be diligently searched and the materials carefully studied, with a view to discovering these certainly merely "missing links" of a chain that can but have been once complete.

It is remarkable that in both its flora and its fauna the life of this continent has been thus abruptly truncated. The sudden irruption of a perfectly developed mammalian fauna at the beginning of the Tertiary is not less astonishing than the appearance unannounced of many hundreds of species of highly organized dicotyledonous plants in the Middle Cretaceous. The advocates of special creation, and likewise the hunters after a lost Atlantis, were they informed upon the facts which science itself so plainly teaches, could ask no stronger argument for either of their positions. But such persons are usually not so informed, and it seems almost impossible for them to become so and still hold such views, for, fortunately, knowledge is a poison that contains its own antidote, and the very possession of the facts suffices to preclude a perverse use of them.

XLV.—*Descriptions of new Species of Reptiles and Batrachians in the British Museum.*—Part II. By G. A. Boulenger.

Blanus Bedriagæ, sp. n.

In a recent paper *, Dr. J. v. Bedriaga has established the specific distinctness of two forms of Amphisbænas which have hitherto been confounded under the name of *Blanus cinereus*, Vandelli, viz. a Western form, inhabiting the Spanish peninsula, Morocco, and Algiers, for which the name *B. cinereus* must be retained, and an Eastern form, occurring in Asia Minor, which he named *Amphisbæna Strauchi*. My attention being drawn to this question, I have reviewed the series of *Blanus* in the British Museum; and the result has not only confirmed Dr. v. Bedriaga's conclusions, but brought to light a third form, represented by several specimens from the river Xanthus, Asia Minor, and which must likewise be regarded as a species, which I will name *B. Bedriagæ*; its characters are as follows:—

Intermaxillary teeth seven, maxillaries three on each side, mandibulars seven on each side. Snout prominent. Three lower labials, the first and second large, the third small; the suture between the frontal and the second labial nearly as long as that between the latter and the ocular. No cervical fold separating the head from the body. Annuli 101 to 114 on the body, 19 to 21 on the tail; an annulus contains 16 to 18 dorsal and 18 to 20 ventral segments. Preanal pores ten.

The other Oriental specimens of *Blanus* in the collection, and which bear the localities Constantinople and valley of the Meinder, agree in every respect with *B. Strauchi*, of which a specimen from Smyrna has been obtained from Dr. v. Bedriaga.

Stenostoma affine, sp. n.

Allied to *S. albifrons*, but distinguished by the much larger

* Arch. f. Naturg. 1884, p. 23, pl. iv.

anterior labial shield, which is broader than either the naso-labial or the oculo-labial. Supraocular separated from the anterior labial. 7 longitudinal and 215 transverse series of scales. Brown above, brownish white beneath; the centre of the scales darker, but not forming such conspicuous markings as in *S. albifrons*. Total length 205 millim.; tail 16 millim.; diameter of body 4 millim.

One specimen from the province of Tachira, Venezuela.

Rana Masonii, sp. n.

Vomerine teeth in two slightly oblique series between the choanæ. Head moderate; snout rounded, slightly longer than the diameter of the orbit, with strong canthus rostralis; loreal region deeply concave; interorbital space a little broader than the upper eyelid; tympanum very distinct, half the size of the eye. Fingers rather slender, first extending slightly beyond second; toes moderate, nearly entirely webbed, tips of fingers and toes dilated into small disks; subarticular tubercles strong; inner metatarsal tubercle small, oval; no outer metatarsal tubercle. Hind limb very long; if carried forward, the femoro-tibial articulation reaches the axilla, and the tibio-tarsal articulation far beyond the tip of the snout. Skin smooth; a well-marked glandular lateral fold. Brown above; a blackish streak under the canthus rostralis and a large blackish temporal spot; tympanum light, dark in the centre; limbs with dark cross bars. Lower surfaces whitish, brown-mottled on the throat and breast. From snout to vent 68 millim.

Near *Rana jerboa*, Gthr., but well distinguished by the shorter hind limb.

A single female specimen, from near Batavia, was presented by G. E. Mason, Esq.

Microhyla fissipes, sp. n.

Habit slender. Snout truncate, slightly longer than the orbital diameter; interorbital space broader than the upper eyelid. Fingers slender, first much shorter than second; toes long and slender, free, with a slight lateral fringe; tips of fingers and toes not swollen; subarticular tubercles distinct; two rather small, obtuse, metatarsal tubercles. The hind limb being carried forward along the body, the tibio-tarsal articulation reaches the eye. Skin nearly smooth above, with small warts on the sides. Olive-brown above, the small warts tinged with red; a darker lateral band from the tip of the snout, passing through the eye down to the middle of the side; an elongate X-shaped darker marking commencing between the eyes, and another, Λ-shaped, on sacral region; limbs with dark cross bars. From snout to vent 26 millim.

One specimen from Taiwanfoo, S. Formosa.

Cæcilia Buckleyi, sp. n.

Maxillary teeth rather large, about 10 on each side; vomeropalatines 8 on each side; inner mandibulars small, few; outer mandibulars large, especially the most anterior, 9 on each side. Snout broad, rounded, not very prominent, shorter than the distance between the eyes; latter very distinct; tentacle below the nostril. Body short for the genus, cylindrical; 175 circular folds, all complete. Tail indistinct, rounded. Olive above, lighter beneath and round the lower jaw; throat olive. Total length 160 millim.; diameter of body 4 millim.

A single specimen, probably young, collected at Intac, Ecuador, by Mr. Buckley.

XLVI.—*On the Genus* Megascolex *of Templeton.* By F. E. Beddard, M.A., F.R.S.E.

In a recent paper by Dr. Horst* of Leyden, the author, in describing a collection of earthworms belonging to the genus *Perichæta* of Schmarda, takes occasion to point out the identity of this genus with another genus established fifteen years previously by Templeton, viz. *Megascolex*. Having recently had an opportunity, through the kindness of Dr. Traquair and Prof. F. Jeffrey Bell, of examining several specimens preserved in the British Museum and the Edinburgh Museum of Science and Art, which are undoubtedly Templeton's *Megascolex cæruleus*, I think it worth while to point out that these two genera, *Megascolex* and *Perichæta*, are by no means identical, but present numerous and important differences. In the paper already mentioned Dr. Horst recapitulates the main points in Templeton's original description of *Megascolex cæruleus*, and calls attention to the misinterpretations of this description introduced by subsequent writers; there is no doubt that these misinterpretations, for which Schmarda is mainly responsible, in reality caused Perrier† and Vaillant‡ to separate the genera *Megascolex* and *Perichæta* in their tables of classification, since there is nothing in Templeton's description itself which would

* Notes from the Leyden Museum, vol. v. no. xvii.
† Nouv. Arch. du Mus. t. viii. (1872).
‡ Ann. Sci. Nat. sér. 5, x. (1868).

serve to clearly differentiate the two. Templeton's original notice of *Megascolex cæruleus* is contained in a letter read before the Zoological Society of London in 1845* ; but the facts given chiefly relate to certain external characters and are not at all sufficient to determine the systematic position of the earthworm. The setæ are stated to be arranged in a continuous ring round each segment, except in the mesial line of the back, where they are altogether wanting, while the generative organs occupy segments 16, 17, 18. The latter part of the description is too vague to be of any use, since it is not clear what is meant by "generative organs," whether the testes and ovaries, their external apertures, or, finally, the segments upon which the clitellum is developed. Schmarda† distinguished his genus *Perichæta* mainly by the arrangement of its setæ; his generic definition is as follows:—"Setæ totam segmentorum circumferentiam in formâ annuli cingentes." He mentions Templeton's genus *Megascolex* as having the setæ developed *only* upon the back, and, in fact, entirely reverses the account of the arrangement of the setæ given by Templeton; the "generative organs" of Templeton's description Schmarda interprets as the clitellum. In 1869‡ Baird examined the type specimens of *Megascolex cæruleus* in the British Museum, and came to the conclusion that there was no difference of importance (indeed no difference at all, except size) between that genus and *Perichæta*. The only structures, however, which he seems to have compared with any care in the two forms are the setæ; and these are precisely the very worst characters that could have been chosen to determine such a question. It is impossible to arrive at any correct notion about the systematic position of an earthworm without an examination of its internal structure and the relations of the male generative apertures to the clitellum. Vaillant§, and afterwards Perrier‖, more fully demonstrated the importance of the latter character; and Perrier has sufficiently shown how earthworms, similar in external characters, may differ most widely in their anatomy; moreover Baird's figures of the setæ of *Megascolex cæruleus* and *Perichæta diffringens do* show some slight differences, quite enough to distinguish them if it were at all possible to make use of such a trifling external character. Baird makes no statements at all about the clitellum and generative pores in *Megascolex*.

* P.Z.S. 1845, p. 89.
† Neue wirbellose Thiere (Leipsic, 1861), Bd. i. 2.
‡ P.Z.S. 1869, p. 40.
§ Ann. Sci. Nat. *loc. cit.*
‖ Nouv. Arch. &c. *loc. cit.*

Dr. Horst, in the paper already quoted, entirely agrees with Baird's identification of *Megascolex* with *Perichæta*, and naturally points out that the latter name must be cancelled, since *Megascolex* has a priority of fifteen years. Although the last-named author does not state his own reasons for this identification, but relies chiefly upon Baird's authority, any one reading Templeton's description would naturally think that the earthworm presented no points of generic difference from *Perichæta*; the distribution of the setæ is not sufficiently peculiar to mark off the genus *Megascolex* from *Perichæta*, inasmuch as we know that a *continuous* ring of setæ is not always found in species which would unhesitatingly be assigned to the genus *Perichæta*. The only other point in Templeton's description, the account of the generative organs, might well be referred to the apertures of the male generative ducts upon the 18th segment and to genital papillæ, such as are frequently found in *Perichæta*.

None of the specimens in the British Museum nor the single specimen in the Edinburgh Museum had the clitellum fully developed, though in one specimen segments 13–19 showed a slightly different colour from the rest of the body, which is doubtless a trace of a clitellum in a condition of development or degeneration. The specimen in the Edinburgh Museum, which presents an interesting peculiarity to be described shortly, Dr. Traquair kindly allowed me to open, and I at once ascertained that it was identical with an earthworm recently described by myself* as new, under the name of *Pleurochæta*; I was able to verify my description and to add some details as well as to make one or two corrections. The specimen in the Oxford Museum had a fully developed clitellum, extending from the 13th to about the 20th segment, and therefore *beyond* the apertures of the male generative duct, which are in segment 18. This fact alone is amply sufficient to show that there can be no possibility of confounding this earthworm with *Perichæta*, seeing that in this latter genus, as is well known, the clitellum occupies certain segments *anterior* to the openings of the male generative ducts, which only agree with those of *Megascolex* (as also of other genera, e. g. *Pontodrilus*) in being situated upon the 18th segment and in being provided with a prostate gland. The absence of a fully developed clitellum in the specimens of *Megascolex* contained in the national collection renders it, of course, more difficult to distinguish this genus from *Perichæta*, though a careful examination even of these specimens, and with regard to external characters only, reveals at once certain points of difference.

* Trans. Roy. Soc. Edinb. vol. xxx. pt. ii.

In all the specimens, with one exception, the ventral surfaces of the 17th, 18th, and 19th segments are traversed by two thick glandular folds (the remnant of the clitellum), differing by a yellowish colour from the surrounding integument, and separated from each other by a space of about $\frac{1}{4}$ inch: in the groove on the inner side of each of these folds are situated the male generative apertures and two papillæ; the former lie in the middle of the 18th segment, just in front of the row of setæ which traverses it, whilst the latter are upon the boundary-line between segments 17–18 and 18–19 respectively; the rows of setæ upon segments 17, 18, and 19 stop short at the outer edge of the glandular fold. Although it is well known that many species of *Perichæta* possess genital papillæ in the neighbourhood of the male genital apertures, an inspection of Perrier's figures of these structures at once shows that they are not quite the same as those of *Megascolex*; instead of being upon the boundary-line between two segments, they are quite in the middle of a segment in the region occupied by the row of setæ. In one of the five specimens of *Megascolex* that are in the national collection the male genital apertures and the papillæ, instead of being hidden away at the bottom of a deepish groove, are situated upon the upper surface of an oval longitudinal swelling which extends over exactly the same number of segments as the longitudinal fold. Upon the 13th segment are two apertures, which are most probably the external openings of the oviducts; like the male generative apertures they are placed just in front of the row of setæ. The specimen in the Edinburgh Museum, which in other respects showed a perfect agreement with the five of *Megascolex* in the British Museum, has only *a single oviducal aperture* situated upon the middle of the ventral surface of the same segment and surrounded by a circular area differing somewhat in colour and appearance from the rest of the integument.

With regard to the internal structure of *Megascolex* I have nothing to add to my former description, where the numerous differences between *Megascolex* and *Perichæta* are indicated. I append a definition of the two genera.

PERICHÆTA, Schmarda.

Perichæta, Schmarda, Neue wirbellose Thiere, 1861, Bd. i. 2.
Megascolex, Baird, P. Z. S. 1869, p. 40.
Perichæta, E. Perrier, Nouv. Arch. du Mus. 1872.
Megascolex, Horst, Notes Leyden Museum, vol. v., note xvii. p. 182.

Setæ generally arranged in a continuous row round the middle of each segment; clitellum occupying 2, 3, or 4 segments (14–17). Male generative apertures paired, and situated upon 18th segment of body, which is always *behind* the clitellum; genital papillæ occasionally developed in neighbouring segments. Female generative aperture single, and within the clitellum upon the 14th segment. Two pairs of testes, more or less solid and compact, in segments 11 and 12; terminal portion of vas deferens on either side connected with the duct of a large prostate gland. Copulatory pouches varying in number from two to four pairs, and provided each with a variously shaped supplementary pouch or pouches. Intestine with a cæcum on either side in 20th segment*.

MEGASCOLEX, Templeton.

Megascolex, Templeton, P. Z. S. 1845, p. 89.
Pleurochæta, F. E. B., Trans. Roy. Soc. Edinb. vol. xxx. pt. ii.

Setæ arranged in nearly a continuous row round each segment, only failing for a short space in the dorsal and ventral median lines; clitellum occupying segments 13–20, but not developed upon the area which separates the male genital apertures and papillæ of one side from those of the other. Male genital apertures paired and situated upon 18th segment of body, which is within the area over which the clitellum extends; genital papillæ two pairs, developed upon boundary-line between 17th–18th and 18th–19th segments respectively. Female generative pore single or double, upon 14th segment. A single pair of testes, branched and racemose, in 12th segment; a large prostate gland on either side in 18th segment. Copulatory pouches simple and unprovided with any supplementary pouches; two pairs situated in segments 8 and 9. Intestine with no cæcum, but with a series of large compact glands arranged in fifteen or sixteen pairs, commencing at about segment 106.

XLVII.—*On the Hymenoptera collected during the recent Expedition of H.M.S. 'Challenger.'* By W. F. KIRBY, Assistant in Zoological Department, British Museum.

THE series of Hymenoptera collected during the voyage of H.M.S. 'Challenger' is interesting not only on account of several apparently new species having been obtained, but because

* In two species, *P. Sieboldi* and *P. musicus*, Horst ('Notes Leyden Museum,' &c. pp. 192 & 194) describes six of these cæca on each side; but in the latter species, at least, they do not seem to be at all regular in their presence.

most of the specimens were obtained from localities which have been but little worked; and consequently the greater part were brought from countries which they were not previously known to inhabit. A list is given below.

HYMENOPTERA TEREBRANTIA.

Serrifera.

Tenthredinidæ.

Pterygophorinæ.

1. *Pterygophorus analis.*

Pterygophorus analis, Costa, Ann. Mus. Nap. ii. p. 66 (1864).

Sydney, May 1874.

ENTOMOPHAGA.

Spiculifera.

Chalcididæ.

Eucharinæ.

2. *Schizaspidia Murrayi.*

Long. corp. $1\frac{1}{2}$ lin.

Male.—Closely allied to *S. nasua*, Walk., from the Philippines. Head and thorax green, granulated, with a slight coppery reflection; antennæ yellowish brown; scape yellow beneath; flagellum with seven long rami before the extremity, which divides into two equal rami, shorter than the others; scutellum sloping upwards, more shortly constricted than in *S. nasua*, and terminating in a blunt fork, about as long as the first portion; abdomen subpetiolated, vertical, smooth and shining, blackish green on the sides, and with a broad yellowish stripe above, continued round backwards to the extremity; legs yellowish. Wings hyaline; subcostal nervure rather thick, blackish; stigma short, blackish, well defined.

Tongatabu, July 1874.

Evaniidæ.

3. *Evania lævigata.*

Evania lævigata, Latr. Gen. Crust. et Ins. iii. p. 251 (1807).

Honolulu.

Braconidæ.

4. *Bracon trisignatus.*

Female.—Exp. al. $10\frac{1}{2}$ lin.

Head, thorax, legs, first and base of second segment of abdomen pale luteous; abdomen whitish beneath; antennæ, vertex as far as the antennæ, three spots on thorax, the greater part of the abdomen above, hind tibiæ except at base, and hind tarsi black; ovipositor red, sheaths black; wings yellow nearly to the middle, and smoky black beyond; stigma not coloured.

Zamboanga, Philippines, Oct. 18, 1874.

5. *Bracon stigmaticus.*

Female.—Exp. al. 12 lin.

Luteous; head pale yellow; antennæ black, the scape luteous beneath; wings yellowish hyaline for two fifths of their length, the remaining three fifths being smoky brown; stigma ivory-white; abdomen with the first three segments luteous above, but paler than the thorax, the remainder of the abdomen black above, the last two segments narrowly edged behind with white; abdomen white beneath, except the valves of the ovipositor, which are black; ovipositor red, sheaths black; legs red, hind tarsi black.

Ki Dulan, Sept. 25, 1874.

HYMENOPTERA ACULEATA.

PRÆDONES.

Heterogyna.

Formicidæ.

Formicinæ.

6. *Formica nigra.*

Formica nigra, Linn. Syst. Nat. ed. x. vol. i. p. 580 (1758).

Bermuda, April 1873.

Perhaps introduced. The specimens do not appear to differ from the ordinary European species.

7. *Camponotus maculatus.*

Formica maculata, Fabr. Spec. Ins. i. p. 491 (1781).

San Jago, Cape Verdes, Aug. 11, 1873; Cape of Good Hope, Nov. 1873.

A common species throughout tropical and subtropical Africa.

8. *Camponotus intrepidus.*

Formica intrepida, Kirby, Trans. Linn. Soc. Lond. xii. p. 477 (1818).

Sydney, May 1874.

9. *Polyrhachis bihamata.*

Formica bihamata, Drury, Ill. Ex. Ent. ii. pl. xxxviii. figs. 7, 8 (1773).

Zamboanga, Philippines, Feb. 1875.

10. *Polyrhachis sculpturata.*

Polyrhachis sculpturatus, Smith, Journ. Linn. Soc. Lond., Zool. v. p. 70 (1861).

Zamboanga, Philippines, Feb. 1875.

Previously recorded from Celebes, Salawatty, Timor, and Siam, but not from the Philippines.

11. *Polyrhachis phyllophila.*

Polyrhachis phyllophilus, Smith, Journ. Linn. Soc. Lond., Zool. v. p. 69 (1861).

Zamboanga, Philippines, Feb. 1875.

Previously recorded from Sumatra and Celebes.

12. *Polyrhachis latifrons.*

Polyrhachis latifrons, Roger, Berl. ent. Zeitschr. vii. p. 155 (1863).

Amboina, Oct. 1874; Cape York, Torres Straits.

Originally described from Java.

13. *Polyrhachis neptunus.*

Polyrhachis neptunus, Smith, Journ. Linn. Soc. Lond., Zool. viii. p. 69, pl. iv. fig. 2 (1865).

Amboina, Oct. 1874.

This species was originally described from New Guinea. In many of the specimens the antennæ and legs are more ferruginous than in the typical form.

Odontomachinæ.

14. *Odontomachus hæmatodes.*

Formica hæmatoda, Linn. Syst. Nat. ed. x. vol. i. p. 582. n. 16 (1758).

Ki Dulan, Sept. 25, 1874.

Ponerinæ.

15. *Lobopelta diminuta.*

Ponera diminuta, Smith, Cat. Hym. Ins. B. M. vi. p. 89 (1858).

Zamboanga, Philippines, Feb. 1875.

Widely distributed in the Eastern Archipelago, but not previously recorded from the Philippines.

16. *Paraponera clavata.*

Formica clavata, Fabr. Syst. Ent. p. 394 (1775).

Bahia, Sept. 1873.

17. *Typhlopone punctata.*

Typhlopone punctata, Smith, Cat. Hym. Ins. B. M. vi. p. 112 (1858).

Cape of Good Hope.

Myrmicinæ.

18. *Aphænogaster hostilis.*

Atta hostilis, Smith, Cat. Hym. Ins. B. M. vi. p. 165 (1858).

Simon's Bay, Cape of Good Hope, Dec. 1873.

Smith describes the female and the worker minor. The pair in the 'Challenger' collection agree with a series from Natal, which I take to belong to the worker major. They are much darker than the small specimens; but the workers of this genus differ very much in colour.

19. *Atta abdominalis.*

Œcodoma abdominalis, Smith, Cat. Hym. Ins. B. M. vi. p. 184 (1858).

Bahia, Sept. 1873.

Fossores.

Mutillidæ.

20. *Mutilla diadema.*

Mutilla diadema, Fabr. Mant. Ins. i. p. 311 (1787).

Bahia, Oct. 1873.

Scoliidæ.

21. *Dielis Wallacei.*

Male.—Exp. al. 12 lin.

Black; abdomen with a steel-blue lustre, the greater part of the body more or less clothed with short grey hair, which is especially dense upon the metathorax; clypeus narrowly bordered below with yellow, and the mouth-parts, above the closed mandibles, of the same colour; mandibles black, the extreme tips red; abdomen with the first two dorsal segments bordered with yellow behind, the border on the second interrupted in the middle; the third segment is marked with a faint spot of the same colour on each side, on its hinder edge; wings violaceous hyaline, with chestnut-brown nervures; tegulæ chestnut-brown.

Ki Dulan, Sept. 2, 1874.

Allied to *D. agilis*, Smith, from Celebes, but quite distinct.

22. *Dielis extranea.*

Exp. al. 11 lin.

Male.—Black; clypeus incised, yellow below; labrum yellow, with a black spot in the angle formed by the clypeus; thorax clothed with greyish pubescence; prothorax and tegulæ yellow, a black stripe, narrowly edged below with yellow, running towards the tegulæ, and bounding the yellow colour on each side; scutellum and postscutellum and the sides of the metathorax behind yellow; the lateral sutures of the mesothorax may also be yellow, but this is much obscured by the villous covering; abdomen with the first three segments broadly bordered with yellow behind, and most broadly at the sides; on the under surface the second and third segments are bordered with yellow behind, this colour being interrupted in the middle; wings yellowish hyaline, with chestnut nervures; front legs yellow, front femora black above; middle legs yellow above, the femora with a black basal stripe above and beneath; the tibiæ and tarsi and a small spot at the tip of the femora black beneath; hind legs black; the femora and a short line on the outside of the tibiæ yellow.

Wild Island (Admiralty Islands).

Allied to *D. aurulenta*, Smith, a Philippine species.

Bembicidæ.

23. *Monedula signata.*

Vespa signata, Linn. Syst. Nat. ed. x. vol. i. p. 574 (1758).

Bahia, Sept. 1873.

Larridæ.

24. *Tachytes pompiliformis* (?).

Larra pompiliformis, Panz, Faun. Germ. Heft 89, pl. xiii. (1805).

St. Vincent, Cape Verdes, July 1873.

25. *Sphex maura*.

Sphex maura, Smith, Cat. Hym. Ins. B. M. iv. p. 255 (1856).

Zamboanga, Philippines, Feb. 1875.
Originally described from Celebes.

26. *Sphex sericea*.

Pepsis sericea, Fabr. Syst. Piez. p. 211 (1804).

Amboina, Oct. 1874.

27. *Pelopæus chalybæus*.

Pelopæus chalybæus, Smith, Cat. Hym. Ins. B. M. iv. p. 229 (1856).

Cape of Good Hope, Nov. 1873.

Pompilidæ.

28. *Priocnemis atlanticus*.

Long. corp. 6 lin.

Male.—Black, orbits (except on the vertex) and mouth-parts red; antennæ straw-coloured, scape of a redder shade; lateral angles of the prothorax prominent, and, as well as the tegulæ, red, shining; abdomen with a coppery-green lustre; legs (especially the front ones) more or less shading into ferruginous; wings with a strong greenish-purple iridescence.

The female differs from the male in having the greater part of the head red; the green lustre of the abdomen is much less distinct, and the wings are of a violet-purple rather than of a greenish lustre.

St. Vincent, Cape Verdes, 1873.

Allied to *P. exasperatus*, Smith, from Natal, but differs in the colour of the head.

29. *Pepsis collaris*.

Female.—Long. corp. 11 lin. Black, with dull bluish-green tints. Face greenish; antennæ: scape black; 2nd, 3rd, and apical joints black above and grey below, the intermediate joints yellow. Prothorax black, the sides varied with green and bordered behind with grey pubescence, indistinct above, but very conspicuous below the black tegulæ, and on the sides. Mesothorax velvety black or silky green, according to the light. Metathorax inky black, with a double longitudinal carina, and transversely striated; abdomen black, tinted with verdigris-blue on the upper side; legs black, violet-blue above; wings violaceous, an indistinct transverse yellowish crescent near the end of the radial cell; face, thorax, and tip of abdomen clothed with rather long divergent hairs.

Bahia, Sept. 1873.

Allied to *P. mutabilis*, St.-Farg.

30. *Pepsis cœrulea.*

Sphex cœrulea, Linn. Syst. Nat. ed. x. vol. i. p. 571 (1758).

St. Thomas, March 1873; Bahia, Sept. 1873.

31. *Pepsis stellata.*

Sphex stellata, Fabr. Ent. Syst. ii. p. 217 (1793).

St. Thomas, March 1873.

32. *Pepsis xanthocera.*

Pepsis xanthocera, Dahlb. Hym. Eur. i. p. 120 (1845).

San Jago, Cape Verdes, Aug. 10, 1873.

DIPLOPTERA.

Eumenidæ.

33. *Eumenes colona.*

Eumenes colona, Sauss. Guêpes Solit. p. 70 (1852).

St. Thomas, March 1873.

34. *Odynerus atlanticus.*

Long. corp. 4 lin.

Female.—Black, closely punctured; clypeus convex, bidentate at the apex; sides and lower surface of clypeus, a dot between the antennæ, their lower surface, especially the scape beneath and towards the tip, prothorax above, and the sides in front, tegulæ, and legs red; mesothorax with a shallow and inconspicuous channel above, on each side; abdomen: first segment red, with a black spot in front; second segment black above, with the sides, hinder edge, and under surface red; wings smoky hyaline, with blackish nervures.

St. Vincent, Cape Verdes, July 1873.

Differs from most other black species with red markings by the black scutellum.

Vespidæ.

35. *Belenogaster bidentatus.*

Exp. al. 12 lin.

Female.—Black, mouth-parts pale testaceous; clypeus with the sides emarginate beneath; mandibles reddish, a very narrow reddish line behind the upper part of the eyes; antennæ ending in a sharp point; this, the two preceding joints, and the base beneath are testaceous; thorax thickly punctured; the prothorax, a large lateral spot below and rather in front of the black tegulæ, two large spots on the scutellum, contiguous, but not united, the hinder part of the postscutellum, and the sides of the metathorax above (the middle is black and channelled) red; legs red, coxæ black; abdomen black and shining, the petiole rather wide at its extremity, where it is slightly marked with reddish beneath and on the lateral angles; on the under surface the median line of the petiole is first carinated and then channelled rather beyond the middle; on the under surface is a small projecting tooth on each side.

Pandana, Fiji, Aug. 1874.

36. *Polistes perplexus.*

Polistes perplexus, Cress. Trans. Amer. Ent. Soc. iv. p. 245 (1872).

Bermuda, April and June 1873.
Originally described from Texas.

37. *Polistes aurifer.*

Polistes aurifer, Sauss. Mon. Guêpes Soc. p. 78 (1858).

Honolulu, Aug. 1875.

38. *Polistes rubiginosus.*

Polistes rubiginosus, St.-Farg. Hym. i. p. 524 (1836).

San Jago, Cape Verdes, Aug. 10, 1873.

39. *Polistes fortunatus.*

Long. corp. 7½ lines.

Female.—Ferruginous-tawny, with more or less extended black markings, and clothed with a slight golden pile. Vertex black, the colour sometimes extending as far as the antennæ, and sending off a branch behind to the occiput; in any case the furrows below the antennæ are always more or less marked with black. Clypeus subconvex, sparingly punctured, and more or less yellowish beneath. Antennæ, except the base of the scape, blackish above. Prothorax ferruginous-tawny, narrowly edged behind with yellow; mesothorax black, with or without a U-shaped pale mark in the middle, often accompanied by a small one on each side; pectus mostly black, except some pale spots on the pleuræ; scutellum and postscutellum ferruginous-tawny; metathorax either of the same colour or black, but always with a wide black groove in the centre. When the mesothorax is black there is always a reddish stripe on each side of the groove, beyond which is sometimes another red mark. Abdomen and legs yellowish tawny, the first segment of the abdomen and often some of the succeeding segments narrowly edged behind with yellow; the first segment sometimes marked with black at the base, the second nearly always with a triangular black spot at the base, and occasionally the succeeding segments are also marked with black at the base. The black markings are always more extended on the under surface than on the upper. Wings subhyaline, iridescent.

Described from eight specimens taken at San Jago, Cape Verdes, on the 10th August, 1873. Not closely allied to any known species.

40. *Polistes Madoci.*

Long. corp. 6 lin.

Female.—Black; face ferruginous. Clypeus hairy. Antennæ ferruginous, black above in the middle of the flagellum, the apical portion more yellow; cheeks yellow, with an indistinct dusky spot on the lower part. Prothorax yellow above, with a large black streak running upwards on the sides; mesothorax black, unmarked; tegulæ, scutellum, postscutellum, two stripes on the back of the metathorax, and two narrower ones on the sides, back of the metathorax, knees, tibiæ, and tarsi yellow; coxæ, femora, and hind tibiæ black; abdomen black, the first four segments bordered with yellow behind, both above and below, except on the first segment, on which it is hardly continued below, but it is continued forwards on the sides of all four segments; hinder segments yellow, tinted with ferruginous. Wings yellowish hyaline.

St. Thomas, March 1873.

Apparently allied to *P. modestus*, Smith, and *navajoë*, Cresson.

41. *Polistes carnifex.*

Vespa carnifex, Fabr. Syst. Ent. p. 365 (1775).

Honolulu, May 1875.

42. *Polistes elegans.*

Polistes elegans, Smith, Journ. Linn. Soc. Lond., Zool. iv. p. 169 (1860).

Ki Dulan, Sept. 25, 1875.

43. *Polistes diabolicus.*

Polistes diabolicus, Sauss. Mon. Guêpes Soc. p. 68, pl. vi. fig. 7 (1858).

Ki Dulan, Sept. 25, 1875.

44. *Polybia occidentalis.*

Vespa occidentalis, Oliv. Enc. Méth. vi. p. 675 (1791).

Small nest and numerous specimens from Bahia. The species does not appear to vary.

ANTHOPHILA.

Apidæ.

DENUDATÆ.

45. *Crocisa scutellaris.*

Nomada scutellaris, Fabr. Spec. Ins. i. p. 487 (1781).

St. Vincent, Cape Verdes, July 1873.

46. *Crocisa nitidula.*

Melecta nitidula, Fabr. Syst. Piez. p. 386 (1804).

Ki Dulan, Sept. 25, 1874.

SCOPULIPEDES.

47. *Xylocopa circumvolans.*

Xylocopa circumvolans, Smith, Trans. Ent. Soc. Lond. 1873, p. 205.

Eucosca Dock, Japan, May 1875.

48. *Xylocopa æneipennis.*

Apis æneipennis, De Geer, Mem. iii. p. 573, pl. xxviii. fig. 8 (1773).

St. Thomas, March 1873; Honolulu, Aug. 1875.

49. *Xylocopa bryorum.*

Apis bryorum, Fabr. Syst. Ent. p. 381 (1775).

Wokan, Dobbo, Aru.

SOCIALES.

50. *Trigona ruficrus.*

Apis ruficrus, Latr. Ann. Mus. Hist. Nat. v. p. 176 (1804).

Bahia, Sept. 1873.

51. *Apis mellifica.*

Apis mellifica, Linn. Syst. Nat. ed. x. vol. i. p. 576 (1758).

Bermuda, April 1873; Sydney, May 1874.

BIBLIOGRAPHICAL NOTICES.

Annual Report and Proceedings of the Belfast Naturalists' Field Club, 1882–83. Ser. 2, vol. ii. part 3. 8vo. 1884.

THE Report for the year ending 31st March, 1883, completes the history of the twentieth year of the Society's existence and work. Besides the reports of the several excursions, in which scientific research and healthy pleasure appear to have been well combined, and of the conversazione and annual meeting, this part contains notices of several interesting papers:—on the crannogs at Lough Mourne, near Carrickfergus (with an illustrative plate); on the stone monuments of Carrowmore, near Sligo; and on Fungi, their properties and uses. Mr. Joseph Wright, in occasional notes, mentions some Foraminifera new to the British fauna, namely *Miliolina triangularis*, *Haplophragmium agglutinans*, and *Lagena castrensis*, the last hitherto known only on the Australian coast. These were dredged by him off Dublin. Also *Rhabdogonium tricarinatum* and *Pullenia quinquelola*, dredged by Messrs. J. Wright and F. P. Blakwill, the first off Lambay Island, in 50 fathoms water, and the second at 45 fathoms about 20 miles off Dublin. A Meteorological Summary for 1883, and the Appendix vii., consisting of a Supplement to a List of Mosses of the North-east of Ireland, by Mr. S. A. Stewart, complete this Report.

Transactions of the Cumberland Association for the Advancement of Literature and Science. No. VIII. 1882–83. Edited by J. G. GOODCHILD. 8vo. Carlisle: G. and T. Coward. 1883.

IT must be a question difficult to settle in the minds of many working naturalists how far they should feel grateful to the swarm of small local societies and field-clubs in all parts of the country which bring out their Transactions and Proceedings as separate and independent publications. In the districts to which the activity of these bodies is devoted such publications are doubtless of great interest, and the societies gain much credit by their production; but it is rather hard upon the student to have to keep himself up to the contents of so many comparatively obscure periodicals on the chance of the appearance in their pages, among a mass of material of purely local interest, of some paper containing important results in connexion with the subject of his special studies.

This difficulty would be certainly not altogether got over, but to a considerable extent diminished, if the members of all our smaller local societies and field-clubs would adopt the same plan as the Cumberland Association, which owes its origin, we believe, to the efforts of the late Rev. J. Clifton Ward. This Association constitutes a central body to which all the local associations in Cumberland are affiliated; it holds one meeting annually, and its meetings are movable feasts, after the fashion of those of the British Association, or, more accurately, the annual meetings of the Tyneside and Berwickshire Field-Clubs; but the Cumberland Association prints in its 'Transactions' not only the papers read at the annual meeting, but also a selection of the more valuable communications made during the year to its affiliated local societies. It is this plan, if it can be carried out without producing heartburnings, that gives a special value to the publications of the Association; the ambition which prompts the secretaries of small local societies to seat themselves in the editorial chair is crushed back by the weight of the Association, and thus the chaff is to a great extent winnowed from the wheat.

Thus in the present number, which contains 215 pages besides the preliminary official matter, we have only twelve articles, two of which, namely the Address of the President, Mr. Robert Ferguson, M.P., and a paper by the Rev. T. Ellwood, relate to the ethnology of the district, treated from a linguistic point of view, while a third, by the Rev. H. D. Rawnsley, deals with the formation of a Lake-District Permanent Defence Society, which we hope may meet with full success in its endeavours; and a fourth, by Mr. Fisher Crosthwaite, gives some curious particulars with regard to an immigration of German miners to Keswick in the sixteenth century. All the rest are of more or less interest to naturalists. For the botanist we have a "Contribution towards a list of Cumberland Mosses," by the Rev. R. Wood, recording the occurrence of 183 species, chiefly in a limited locality, embracing the parishes of Westward and Caldbeck; additions by the same author to the list of Flowering-plants growing in Cumberland; and a note on the Botany of the Calder valley, by Mr. William Hodgson; and the entomologist will find a catalogue of the Lepidoptera of West Cumberland, by Mr. G. Mawson; all of interest in connexion with the geographical distribution of species. An important palæontological article is contributed by Mr. J. Postlethwaite, on the Graptolites of the Skiddaw Slates, in which the author notices all the forms of those curious organisms which have occurred in the formation, and supplements it with a note of the localities where Graptolites have been found in the Skiddaw Slates, and a list of published works relating to the subject. Mr. T. V. Holmes has a short paper on the Geology of the Carlisle basin in connexion with water-supply; and the editor, Mr. J. G. Goodchild, furnishes a contribution towards a list of minerals occurring in Cumberland and Westmoreland, besides a long and exceedingly interesting memoir of the late

Prof. Harkness, whose connexion with the Lake-district and its geology renders such a commemoration on the part of the Cumberland Association peculiarly graceful and appropriate. Mr. Goodchild has had access to many letters addressed to Prof. Harkness by distinguished geologists at home and abroad; and his long extracts from these give additional value to his memoir.

Besides the formal papers above mentioned, the part contains a set of "Local Scientific Notes and Memoranda," relating chiefly to various minor matters of natural history, some of which may have interest for students outside the district. Not content with having written the longest article in the book, the Editor is the principal contributor of these short notes, and, indeed, throughout he seems to have performed his duties in an energetic and conscientious manner, which has naturally led to the production of a most respectable and valuable volume.

MISCELLANEOUS.

On the Structure of the Otocysts of Arenicola Grubii, *Clap.* By M. E. Jourdan.

The author's investigations were made upon the small *Arenicolæ* of the coast of Marseilles and in the laboratory of that place.

By sectioning the cephalic segment of an *Arenicola* previously fixed by the injection of a solution of osmic acid of 0·50 per cent., the auditory capsules were shown in some sections and easily recognized by their little calcareous corpuscles. The otocysts are situated in the thickness of the integuments far from the hypodermis and in the midst of muscular bundles; they are fixed by the connective envelope of these bundles, which surrounds them. They are not in direct contact with the œsophageal commissures, but connected with them by several nerves. They are placed towards the dorsal surface.

The nerve-fibres composing the commissure and the brain are very fine and striated longitudinally. Nerve-cells exist throughout the length of the commissure, some in its interior, but a much greater number between the commissure and the hypodermis, often intimately connecting these two parts.

The otocysts are spherical. The diameter of their cavity is $\frac{11}{100}$ millim. and that of the sphere formed by the outer capsule $\frac{22}{100}$ millim. The thick walls consist of a layer of fusiform cells, a network of fibrillæ arranged in a dense plexus, and a connective envelope. The cells form the greater part of its thickness; they are very delicate, spindle-shaped, slightly inflated towards the middle, where the nucleus is situated; they also increase in thickness towards their inner extremity, where they are surmounted by a thick plate. The plates of all the cells are closely soldered together, forming a cuticle, which, in sections, is often detached from the cells which produced it. No layer of vibratile cilia was to be seen distinctly, but indications of them seemed to exist upon portions which had been long in osmic acid. The cells taper at their base and at the same time bend in different directions; and these basal prolongations anastomose and form a very delicate network of fibrillæ, which, by their union, constitute at the base of the epithelial layer a regular little zone, intermediate between the nerve-fibres and the foot of the cells; a few nuclei are distinguishable in it. This plexus rests against the connective envelope, which is formed by a thin and dense membrane, presenting perforations, through which the basilar plexus enters into relations with the nerve-fibres.—*Comptes Rendus*, March 24, 1884, p. 757.

On Prof. Lindström's Remarks on Prof. Martin Duncan's Criticisms.

To the Editors of the Annals and Magazine of Natural History.

GENTLEMEN,—With reference to Prof. Lindström's communication to the Ann. & Mag. Nat. Hist. for March 1884, p. 162, I wish to inform you that, having sought the opinion of some naturalists well qualified to judge between Prof. Lindström and myself, I find that the language I used was not of a kind to merit the condemnation of being "by no means consistent with the quiet tone that ought to prevail in scientific discussions." It appears to them and to me that Prof. Lindström took unnecessary offence and that his tone was very uncourteous.

I can assure you that nothing was further from my thoughts than to give him personal offence; but he must remember that his communication which I wrote upon was eminently critical, and was bound sooner or later to provoke discussion. I gave the reasons for not having sooner attempted a reply. Probably when some time has elapsed Prof. Lindström will read my essay with more charitable and kindlier feelings; and it may happen that we may criticize one another as Pourtalès and I did, with advantage to ourselves and with the establishment of a sincere friendship.

Yours truly,

April 10, 1884. P. MARTIN DUNCAN.

Reproduction in Amphileptus fasciola. By ANDREW S. PARKER, M.D., Ph.D.

Several years ago, while examining some Infusoria, I noticed a specimen of *Amphileptus fasciola* undergoing some curious changes, the nature of which, at that time, I did not fully appreciate, supposing them to be due to the dissolution of the animal. Recently I observed the same series of phenomena occurring in another individual, and on tracing them out more fully I found that they were due, not to the death of the Infusorian, but to what I believe is a method of reproduction not hitherto observed, or at least not described, in this group. My attention, in both instances, was attracted by a peculiar oscillating movement, the *Amphileptus* rocking from side to side, the animal remaining stationary, although its cilia were in active motion. In other respects the animal appeared normal, no changes being observed in its nucleus, protoplasmic contents, or contractile vesicle. Shortly after I had noticed this peculiar rocking movement I found that the elongated extremity was breaking up into small masses of protoplasm; these gradually separated from the parent body, and each of them exhibited distinct amœboid movements. Although the cilia seemed to break off with the small masses, I could not detect any signs of their presence after separation. For about five minutes small protoplasmic masses, exhibiting distinct and independent amœboid movements, continued to be shed.

The rocking movement still continued, but now began to show signs of being converted into a movement of rotation. Finally a rotary motion was established, and the animal began to change its position. At the same time I noticed a distinct elongation occurring at the end where the changes described above had taken place, a rounded projection appearing, which gradually elongated, until finally, in the course of about two hours, the individual had assumed its original shape and activity, although apparently somewhat diminished in bulk. Cilia covered the new growth, but they did not seem to be a new formation, but were produced by a simple elongation of the ectosarc, this being carried forward by the growing endosarc. As regards the protoplasmic masses that were shed or discharged, I observed them for about four hours, at which time they were still active and the parent mass still in active motion. On the following day I was unable to detect them, and as to their subsequent history I know nothing.

To characterize the phenomena as described above, I propose the term "Reproduction by Partial Dissociation." Reproduction by fission, gemmation, conjugation, and encystation have all been observed in the ciliated Infusoria; and some of the older writers, such as Ehrenberg and others, have described a mode of increase, in which the substance of the body breaks up into a number of fragments, each of which is capable of becoming a distinct individual. This process they called diffluence; but Stein and other more recent observers have denied the existence of this process, claiming that it was merely a form of increase from encysted forms. The phenomena as exhibited by *Amphileptus fasciola* seem to be quite different from those described as occurring in diffluence, and it certainly was not a case of encystation. I have been unable to find any account of reproduction in the Infusoria resembling that described above, and I therefore place the facts on record, in order that the attention of other observers may be directed towards the verification of the phenomena and views expressed above.—*Proc. Acad. Nat. Sci. Philad.* 1883, p. 313.

On the Anatomy of Peachia hastata. By M. Faurot.

The Actinia discovered by Gosse (in 1855), and named by him *Peachia hastata*, is known only by its external characters. Hitherto any exact observation of its internal organization has been impossible, owing to the ruptures which take place in its mesenteroid folds. The insensibility produced by water charged with carbonic acid enables chromic acid to act fatally upon the animal without causing contractions and lesions. When thus treated its internal organization differs considerably from that of all known Zoantharia, including *Cerianthus*, which hitherto presented the most exceptional structure.

Twelve perforated mesenteroid folds at the level of the œsophagus. Two of these folds, close together, instead of detaching themselves from the lower margin of the œsophagus, and floating freely in the general cavity, attach themselves to a gutter-like organ, the two margins of which are approximated. This gutter commences on one of the sides of the peristome, appearing externally as a papilliform lip, and terminates in the general cavity not far from an orifice, analogous to that of *Cerianthus*, which the animal possesses at its lower extremity. Eight longitudinal muscular cords project upon the inner wall. These are arranged in pairs, so that only four chambers out of the twelve possess them. These four chambers are placed unsymmetrically, one on each side of the organ above described, the other two opposite one another upon an axis perpendicular to that which would pass through the papilliform lip and the inferior orifice.—*Comptes Rendus*, March 24, 1884, p. 756.

On a Cilio-flagellate Infusorian recently observed in Baltimore Drinking-Water. By C. S. Dolley*.

Having had my attention called to the presence of large numbers of a peculiar minute green organism in the water-supply of the Biological Laboratory, I became interested in identifying the same, and find it to be a species of *Peridinium*. So far as I have been able to ascertain, the only member of the family Peridiniidæ hitherto described as occurring in America is a salt-water species from the coast of South Carolina. After examining the specimens found here, very carefully, and comparing them with the specific descriptions given by Kent, I find that while they agree in most respects with *Peridinium tabulatum*, they also have many points in common with *Peridinium apiculatum*, though differing in several particulars from both. They would therefore seem to constitute an intermediate species, or variety, if, in accordance with Stein, *P. apiculatum* be regarded as only a variety or older phase of *P. tabulatum*. The characters of our Baltimore specimen are as follows:—Body ovate or subglobose, as seen in dorsal or ventral aspect, with a convex dorsal and concave ventral surface as seen in lateral aspect; cuirass composed of numerous polygonal facets, which in the row next to the equatorial furrow are separated by a clear space; the edges of these spaces as well as of the longitudinal and equatorial furrows are finely hispid. The remaining facets are closely united; all the facets have a very marked reticulate structure, with the exception

* Abstract of some remarks before the University Scientific Association, February 6, 1884.

of the narrow linear ones in the equatorial furrow. There is a deep notch or sulcus in the extremity of the posterior segment continuous with the longitudinal furrow of the ventral surface. The equatorial groove does not remain in the same plane in passing around the body; but upon the ventral surface, where it is joined by the longitudinal furrow, it exhibits a fault, being in fact one turn of a spiral. The margins of the equatorial groove are everted and present laterally the appearance of tooth-like processes. The flagellum is very delicate, and inserted at or near the posterior sulcus in the longitudinal furrow. I was only able to detect it in specimens killed with osmic acid. I could detect cilia only at the posterior sulcus, on each side of which they present a tuft-like appearance.

The eye-like pigment-spots are rather unfrequently present, and vary from one to three or four in an individual, being located at one side of the longitudinal fissure. The colour of the Infusorian is a yellowish green, and its diameter $\frac{1}{520}$ inch. It moves with a rolling motion about its dorso-ventral axis, and was mistaken at first for a *Volvox* or zoospore. It is attracted by light, moves about freely on the slide, but ceases its motion if the slide be jarred or struck. Many of the specimens which had been kept in a large dish seemed to have taken on a resting-stage, the endoplasm being retracted from the walls of the cuirass, and containing numerous oil-globules. I was not able to find any of the "lunate encystments" mentioned by Kent, nor could I make out the existence of an endoplast.

The observations of Mr. Carter of Bombay indicate that the gregarious habit of *Peridinium* may at times render it a potent factor in the contamination of drinking-water, and the peculiar taste of Baltimore water at times may be due in part to large numbers of *Peridinia* dying and decaying in the pipes.—*Johns Hopkins Univ. Circulars,* March 1884, p. 60.

How a Carpenter-Ant Queen founds a Formicary.

Rev. Dr. McCook presented three specimens of fertile queens of the Pennsylvania carpenter-ant, *Camponotus pennsylvanicus.* These had been given him by Dr. Joseph Leidy, who had taken them during the last summer at Wallingford, Delaware Co., Pa. The circumstances under which they were captured afforded a good demonstration of the manner in which a new colony of this and other species is begun, confirming the speaker's own observations and published statements. One specimen was taken, August 9, in a chestnut log; the others, August 14, in the stump of a chestnut-tree. They were enclosed within small cavities about an inch in diameter, and, curiously, the queens had sealed themselves within their nests by closing up the original opening by which they had entered, and from which, as a nucleus, they must have cut out their resident-room and nursery. If, therefore, they sallied forth to obtain food, as they may have done (for Dr. McCook had at various times observed queens wandering solitary), they must have removed the plug or "door," and restored it to its place again upon re-entrance. However, he believed it to be quite within the bounds of probability that a well-fed queen could live without additional food for several weeks—a period long enough to rear a small brood, and also feed the larvæ from the contents of her crop, which might serve as a storehouse of food, as was explained by illustrations of the anatomy of the alimentary canal.

In the same receptacle with the queens were found:—(1) the white oval or cylindrical eggs of the species; (2) larvæ of various sizes, from those just escaped out of the egg (2·3 millim. long) to full-grown (about 10 millim.); (3) the cocoons, or enclosed pupæ; and in one case (4) a callow antling, which had evidently just escaped from its case. This antling was, as indeed all the larvæ and cocoons appeared to be, of the dwarf caste. There are three castes in a formicary of *Camponotus*: the worker-major, the worker-minor, and the minim or dwarf. We may infer that the latter caste is the one which is first produced in rearing a family.

In response to a remark and suggestion made, that the imperfect nurture given to the larvæ, under the peculiar circumstances, might account for the appearance of small workers first in order, Dr. McCook stated that, whatever one might conjecture to have been the fact in the remote origin of these castes among ants, it is certain that when the formicary has been fully peopled with workers, and the food-supply is unlimited, the several castes still continue to appear. Minims, minors, and majors not only abound among the mature insects, but are found among the larvæ and cocoons. These distinctions are a permanent feature of the ant economy; and while it is perhaps not permitted one to say that they are *not* caused by differences in amount or character of the nurture given in the larval state, yet this did not seem at all probable to the speaker. The fact that, in some genera, the workers have also remarkable differences in structure (as of the head, for example, in *Pheidole* and *Pogonomyrmex crudelis*) goes to show that differentiation into castes is regulated by something other than the food-supply.

The above observations are valuable as proving that the females of *Camponotus*, when fertilized, go solitary, and after dispossessing themselves of their wings, begin the work of founding a new family. This work they carry on until enough workers are reared to attend to the active duties of the formicary, as tending and feeding the young, enlarging the domicile, &c. After that, the queens generally limit their duty to the laying of eggs, and, as the speaker had elsewhere fully described*, are continually guarded and restricted in their movements by a circle of attendant workers, or "court."

The above facts are further illustrated and enlarged by a series of observations made by Mr. Edward Potts, in accordance with the

* Proceed. Acad. Nat. Sci. 1879, p. 140; 'Agricultural Ants of Texas,' p. 144; 'Honey and Occident Ants,' p. 41.

speaker's suggestions and directions. On or about June 16, Mr. Potts captured a queen of *C. pennsylvanicus* running across his parlour floor, late at night. He placed it in a bottle, but forgot to examine it until five days later (21st and 22nd June), when he was surprised to find that the ant was alive, and had laid six or eight eggs in the otherwise empty bottle; which eggs, in their various stages of development, she continued to attend for about fifty days. He fed the ant by dropping into her bottle a pinch of white sugar, which he moistened every evening with a drop or two of water; at which times she quitted her otherwise unremitting watch over the eggs and the larvæ, to press her labium for a moment into the sweet fluid, her labial and maxillary palps meanwhile rapidly vibrating with pleasure. The egg-laying was, from the first, very deliberate; one or two eggs were added to the original stock from time to time, until about the 15th August, making the highest number counted, of all ages, nineteen.

He did not observe the date of the first hatching, but these larvæ, at first no larger than the eggs, and only distinguishable upon close observation by the slight grooves between the body-segments and the ill-defined head, grew gradually at first, and afterwards more rapidly, and reached finally a length of about $\frac{1}{4}$ inch and began to spin their cocoons. On the morning of July 20, the first was surrounded by a single layer of web, but could still be seen working inside it. By evening the cocoon was too opaque to be seen through. On the morning of the 21st the second larva was covered in like manner, and the third by the evening of the 22nd. For some days he was able to detect the dark form of the young ant in one of these cocoons, and on the evening of August 11 a worker was running about the bottle and already essaying its administrations upon the undeveloped eggs and the next series of larvæ, quite as big as and much heavier than itself. We have, then, the period from, say June 20 to July 20 (thirty days), occupied in the development of the first eggs and the fulfilment of the larval stage; from July 20 to August 11, say twenty-two days, were spent in the pupa state.

The manner of the young worker was very nervous and far from soothing, especially to the well-grown larvæ, who evidently much prefer a mother's care to that of an elder sister. He did not observe this antling feeding from the sugar, but upon one or two occasions saw osculatory advances towards its mother, which seemed to indicate that it was not above receiving its nutriment from the maternal fount to which it became accustomed during its wriggling youth. It constantly climbed over the eggs and larvæ, apparently nipping them with its mandibles, but not moving them to any purpose. He saw no well-defined attempt at feeding them on its part; though, after patient observation, upon several occasions, he observed this act performed by the parent ant. She would caress the larva by sundry pats with her antennæ upon each side of the face, when, if hungry, it would lift up its head under her mandibles, placing its labium against hers, at which time a flow of liquid down the larval throat was seen.

As the queen's labours increased, she was less given to moving her charges from place to place, though they were not allowed to remain long quiescent. While nervously anxious about them, Mr. Potts thought that she showed little evidence of tenderness in her treatment, trampling on them with her feet or dragging them around under her heavy abdomen, as if they were really the putty they looked like.

The moisture necessary for the cleansing and growth of the larvæ was apparently supplied from the tongue of the caretaker, who examined them one after another, moistening the dry places and keeping the egg and larval skins flexible. The queen was very careful of the eggs, standing nearly all the time with her head over the little heap, occasionally picking them up to move them a quarter of an inch or more to one side. She was thrown into a great excitement of solicitude when a fly, attracted by the crumbs, intruded within her domicile. She sprang fiercely at the fly and raged around her narrow compartment, seizing a group of eggs as if to escape with them from a threatened danger, then replacing them as though recognizing the impossibility of getting away. Her demeanour on this occasion indicated strong maternal solicitude.

Mr. Potts made some attempt to follow the embryonic changes, and made a few drawings of the different phases. When first seen the egg is full of fluid, uniform in appearance throughout. When next observed segmentation had taken place and advanced to the morula stage, showing everywhere small granular cells of uniform size. Afterward a hyaline spot appears at one end of the egg, which there seems empty or filled with a homogeneous fluid; next to which are large cells, containing smaller ones of various sizes. Later both ends become transparent, the large cells bounding the small-celled body-cavity and forming the well-known gastrula condition. He was not able to trace the formation of the various internal or external organs. The cyclosis of pulsation of the larval heart was counted in two instances at forty-five and fifty per minute.

The manner of ovipositing (August 13) the nineteenth egg is thus described:—When first observed the queen stood up high upon all three pairs of legs, the abdomen thrown forward between them and the head bent back almost to meet it. The egg was then about half protruded. Considerable muscular action was visible throughout the abdomen, and when presently the egg was posited she straightened herself out with a visible air of relief, but forgot all about the egg, which was left lying under her for several minutes while she attended to other matters, until at last, accidentally touching it with one antenna, she picked it up and carried it to the family apartments, where, presently, the worker found it and placed it in the group of the older eggs. An evident intent at classifying the eggs and larvæ was remarked, these (within the narrow limitations of the chosen space) having been kept to a good degree separate.

August 13, another worker was released from its cocoon. Mr. Potts did not see the act, but believed that the female assisted, as she was seen standing over the neophyte, who seemed to be weak, its femora bent forward, the tarsi and tibiæ still nearly reaching the end of the abdomen, indicating the manner in which the legs were folded in the cocoon. Immediately after release the mother gave the young imago nourishment in the manner above described.

At this date there were in the formicary, beside the mature ants, two full-grown larvæ, very fat, two about half-grown, and several smaller ones, with the eggs in different stages of development. The two oldest were then evidently about ready to spin, but what chance they could have, with the mature ants continually trampling over them, standing them up on end or hauling them off to a distance, Mr. Potts was at a loss to imagine. From the mouth of one he observed a strand of silk protruding, but the workers came, apparently trying to grasp it, and left him in doubt whether their object was to help or hinder the weaving process.

August 14, one of the two full-grown larvæ was found wrapped in its winding sheet. The web was very thin and the motion of the larva readily seen through it. The other larva seemed almost totally quiescent, but careful examination with a Coddington lens showed some muscular action in the posterior segments of the body. Their state of comparative torpor was thought to immediately precede the act of spinning. At this date the workers had become less nervous in their motions, and the female seemed to have resigned most of her labours to them, resting much of the time quietly in one place.

August 16, the third worker had emerged and was found quite at home in attending to its duties. The second grown larva was then still uncovered and quiescent. Very close observation was required to show that it still breathed, and it made no other visible motion.

These observations of Mr. Potts establish or confirm the following points:—(1) The manner of depositing the eggs, which, as well as the larvæ, are cared for by the queen until the workers are matured; (2) the stages in the development of the egg and larva are partially noted; (3) the time required for the change from larval to pupal state is about thirty days; (4) about the same period is spent in the pupa state, the entire period of transformation being about sixty days; (5) the work of rearing the first broods of *Camponotus* begins in the latter part of June or early in July; (6) about twenty-four hours are spent by larvæ in spinning up into cocoon; (7) the ant-queen probably assists the callow antling to emerge from its case; (8) not only the larvæ, but occasionally also the antlings, are fed by the queen; (9) the young workers, shortly after emerging, begin the duty of nurses, caring for the eggs and tending the larvæ. Some of these points thus abstracted and formulated by him Dr. McCook was subsequently able to confirm from observations upon the same queen. His thanks were due to Mr. Potts for the intelligent and successful manner in which his suggestions had been carried out.—*Proc. Acad. Nat. Sci. Philad.*, Dec. 1883, p. 303.

On some new and imperfectly-known Exotic Simple Ascidia. By Dr. R. von Drasche.

The author has submitted the exotic simple Ascidians of the Zoological Museum of Vienna to a revision, the results of which are as follows:—Of the eighteen species described by him ten are new. Of the others some have been very imperfectly described, or at least there was room for remarks and observations tending to complete our knowledge of them. Of the new species the following appear to be particularly interesting on account of their remarkably formed hypophysial tubercles—*Microcosmus Herdmanii* and *Cynthia Roretzii*. In both the tubercle consists of two cones inclined towards each other at an obtuse angle, upon which the ciliated groove is spirally twisted. In *Cynthia Roretzii* the ciliated canal bears teeth, which fit into opposite spaces. A similar tubercle is figured in *Cynthia præputialis*, Heller. A transition from the usual arrangement of the ciliated canals of the tubercles in the same plane towards that above described is shown by *Polycarpa rugosa*, sp. n. The tubercle of *Polycarpa sulcata*, Herdm., has a remarkable form; in it there occur numerous crateriform apertures of the hypophysial canal, reminding one of similar conditions in *Ascidia mamillata*. In *Chelyosoma productum*, Stimpson, a species remarkable for the abundance of its musculature, all the peculiarities of the hypophysial organ described by Julin were again met with.

The new species *Microcosmus Julinii* and *Cynthia mauritiana* are distinguished by spicules both in the test and the mantle. The latter species is closely allied to *Cynthia pallida*, Herdm. *Cynthia sacciformis*, sp. n., contains peculiar spicules, resembling those of *Culeolus*, Herdm. Spicules were also detected in *Boltenia pachydermatica*, Herdm.

A new *Cynthia* (*C. mirabilis*) is particularly interesting. Its branchial and cloacal apertures are placed at the opposite ends of the ovate body. The remarkable distribution of the musculature and the peculiar position of the digestive and generative organs caused by the abnormal position of the apertures seem to the author to furnish characters which, in the event of the discovery of other similar species, may justify the establishment of a new genus. *Cynthia nodulosa*, sp. n., is distinguished by an enormous annular muscle situated at the base of the siphons, as also by the spinosity of the ring-membrane. *Cynthia castaneiformis*, sp. n., which in external aspect resembles *C. echinata*, is remarkable for a branchial sac, the inner longitudinal vessels of which only embrace between them three large circular stigmata. *Corella novaræ*, sp. n., very closely approaches *C. eumyota*, Traustedt, from which species it is distinguished by its differently formed hypophysial tubercle and the great number of tentacles.—*Anzeiger der k. k. Akad. der Wiss. in Wien*, March 20, 1884, pp. 66, 67.

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XLVIII.—*On the Origin of the Fauna and Flora of New Zealand.* By Captain F. W. HUTTON *.

I. THE AUSTRALIAN AND SOUTH-AMERICAN ELEMENTS.

Eleven years have elapsed since I read a paper to the Wellington Philosophical Society on the "Geographical Relations of the New-Zealand Fauna" †. During that time the data on which the discussion of this question rests have very much increased, and the literature of the subject has been enriched by the valuable works of Mr. A. R. Wallace on the distribution of animals, works which embody the results of much patient research and acute reasoning. Under these circumstances I wish, in this address, to return to my theme once more. I wish to explain how far I now think my own ideas of 1872 to be erroneous; how far I am able to agree with Mr. Wallace in his view of the origin of our fauna and flora, published in 1880 in 'Island Life;' and how far,

* Presidential Address to the Philosophical Institute of Canterbury, 1st November, 1883. Reprinted from a separate impression from the 'New Zealand Journal of Science' for January 1884. Communicated by the Author.

† Trans. N. Z. Inst. vol. v. (1872), p. 227; and Ann. & Mag. Nat. Hist. ser. 4, vol. xiii. p. 25.

as it appears to me, Mr. Wallace's theory fails to explain the whole of the facts. I also wish to suggest the alterations and additions that seem to be necessary in order to get a good working hypothesis. It will be advisable, however, not to limit ourselves to New Zealand, but to take first a wider view of the subject; for the faunas and floras of Australia and Polynesia are so intimately connected with those of New Zealand, that the origin of the latter cannot well be considered until a general knowledge of the biological and geological history of the Pacific area has been obtained.

Fossil plants have been found in many places in New Zealand, often abundantly and in good preservation, and they belong to several different geological periods. These plants have not yet been described, but they have been examined by Dr. Hector, who has published an abstract of the results of his examination in the 'Proceedings of the New-Zealand Institute,' vol. xi. (1878), p. 536, and in the 'Handbook of New Zealand' (1880). The earliest traces of plants are very obscure, but the Triassic rocks contain ferns (*Glossopteris*), horse-tails (*Schizoneura*), cycads (*Zamites*), and wood of a kauri (*Dammara*). The oldest known extensive flora is of Jurassic age; it consists chiefly of ferns and cycads, which are closely allied to those which inhabited India at the same period, as exemplified by the fossils of the Rajmahal hills. In the Cretaceous rocks numerous dicotyledonous plants occur, forty different species having been distinguished. These, as well as some conifers, belong to species closely allied to those at present living in the country, although some, such as *Araucaria*, have become extinct in New Zealand. In the lower beds of the system these plants are associated with ferns that are also found in the Jurassic strata. The flora of the Tertiary era "is badly preserved, and the collections are scanty; but, as far as yet studied, it bears a very close affinity to the recent flora of the country." It thus appears that the main features of the present New-Zealand flora are very old, dating from the Cretaceous period, with a mixture of still older forms among the ferns and conifers.

Let us now turn to Australia. No fossil plants, so far as I know, have as yet been found in Western Australia, but in Eastern Australia they occur in several places. The Palæozoic rocks of Victoria, New South Wales, and Queensland contain *Calamites*, *Lepidodendron*, and ferns, in some cases identical with plants of the same era in Europe and America. In the Triassic and Jurassic beds cycads and conifers are found, together with the same ferns which occur in New Zealand and in India in equivalent systems. No plants are known of Cretaceous age, but in the Eocene vegetable remains have been found in New South Wales which, according to Baron von Müller and Baron von Ettingshausen, are all extinct forms but little allied to the present Australian flora; for with *Pittosporum*, *Knightia*, and four kinds of *Eucalyptus* there occur birches, alders, oaks, and beeches; while in Victoria extinct tropical trees are found which resemble those of Asia. The fossil plants mentioned by Mr. Darwin at Geilston Bay, near Hobart, in a freshwater limestone of probably Miocene age, are also very different from those now living in Tasmania. They belong, as Mr. Darwin says, to a lost vegetation *. They represent willows, birches, alders, oaks, and beeches, along with *Coprosma*, *Araucaria*, and others. They are more characteristic of Australia than are the Eocene plants; but still both are much nearer to the Tertiary floras of Europe, Asia, and North America than to the recent Australian flora. In beds of newer Pliocene age plant-remains have been found both in New South Wales and in Victoria, and these, according to Baron von Müller, are allied to the present flora of Eastern Australia. What a contrast to New Zealand is here! The present flora of Eastern Australia does not date beyond the Pliocene period, previous to which the country was covered by a lost vegetation allied to the Tertiary floras of Europe and Asia; while in New Zealand, as we have just seen, the present flora dates from the Cretaceous period.

Mr. Wallace has given a very simple explanation of these curious facts. The Australian flora, he says, consists of two large divisions:—(1) the characteristic Australian flora, which is chiefly temperate and hardly represented in New Zealand; and (2) a tropical flora, which is less in number than the first, is closely allied to the floras of India and Malaya, and has many representatives in New Zealand and in South America. Western Australia has no European, Antarctic, or South-American types, but it is far richer than Eastern Australia in true Australian forms, many of which are only found there. He also points out that a submarine ridge, nowhere more than 1000 fathoms below the present sea surface, runs from New Zealand to Northern Queensland, and that the distribution of the Cretaceous rocks in Australia proves that at that period the sea flowed over the centre portion of the continent, dividing the east from the west. From these facts Mr. Wallace infers (1) that the submarine ridge between New Zealand and North-eastern Australia was elevated above the ocean at the same time that Central Australia was submerged; and

* 'Volcanic Islands,' p. 140.

(2) that South-western Australia is the remnant of an extensive isolated continent which received the ancestral forms of its fauna and flora at a very early, probably Jurassic date, by a temporary union with the Asiatic continent over what is now the Java sea ; and it was on this continent that the characteristic Australian flora and mammalian fauna were developed*. He supposes that during the Cretaceous period Eastern Australia, separated from Western Australia by a wide arm of the sea, supported a flora that was principally tropical and of Polynesian type, derived from the north through New Guinea; but, in addition, there were fragments of the typical Australian vegetation which had reached it as stragglers from Western Australia, and also a few south-temperate forms from antarctic lands, which had arrived from Tasmania. New Zealand, which at this time is supposed to have been joined to North-eastern Australia, was open to the immigration of the Polynesian flora and of such Australian types as had reached the tropical portions of Eastern Australia. At the close of the Cretaceous period the northern prolongation of land between New Zealand and Queensland sank; New Zealand was separated from Australia, and has ever since remained isolated with its flora. Eastern Australia remained separated from the west until late in the Tertiary era, when Central Australia was elevated. The flora of Western Australia then invaded the east, and exterminated to a large extent the older tropical vegetation and completely changed the character of the flora.

Such is Mr. Wallace's hypothesis, which, except in some details, is so far satisfactory, the only obvious objections being (1) that the origin of the Australian flora is attributed to a period when no Dicotyledons are known to have existed, and (2) that the majority of the characteristic Australian mammals belong to Eastern and not to Western Australia. These are difficulties, however, which further knowledge may dispel; but the hypothesis cannot be considered as a complete solution of the problem, because one large class of facts is not satisfactorily explained. I allude to the South-American types found in Eastern Australia and New Zealand, many of which belong to tropical and subtropical genera. Mr. Wallace's explanation of the presence of these forms is that a migration took place through New Zealand, South Victoria Land, South Shetland Islands, and Tierra del Fuego over a

* This had been indicated by the Rev. J. Tenison-Woods in the Proc. Roy. Soc. Tasmania, 1875, p. 20, and previously by Prof. Jukes in his 'Physical Structure of Australia,' quoted by Hooker, 'Flora Tasmaniæ,' Intr. p. ci.

greater extension of southern lands during a warm Miocene period. Now Dr. P. Martin Duncan is certainly of opinion that the sea in this portion of the southern hemisphere was much warmer in the Miocene period than at present, and he has suggested that this was due to an extension of the Antarctic Continent up to 50° S. *; but, on the other hand, Mr. Darwin considered the Eocene sea of Chili to have been no warmer than at present, and Mr. Tenison-Woods says that "the whole evidence of the [Tertiary] fossil corals shows a climate and isolation in the New-Zealand fauna not very different from the conditions which exist now," and that the Tertiary fauna of New Zealand generally "is not that of a warm sea, nor like what we should find on the warmer extra-tropical portions of the Australian coast" †. The Miocene Mollusca appear to me to indicate a rather warmer sea; but, as several of the species still live as far south as Foveaux Straits ‡, no elevation of temperature sufficient to take tropical and subtropical plants and animals to 50° S. is probable; and, in addition to other difficulties presently to be mentioned, I shall, I think, be able to show that the South-American connexion is of a far older date than the Miocene. Before doing so, however, it will be necessary to give a short review of the fauna of the Australian region.

In Mr. Wallace's opinion the deep oceans, *i. e.* the Pacific, Atlantic, and Indian Oceans, have been in existence from the earliest geological times. All the principal groups of land animals, he thinks, have originated in the northern hemisphere, and have gradually migrated southwards through the continental extensions of America, Africa, and Australia (including the Indian archipelago), comparatively few having subsequently spread east and west by means of antarctic islands now submerged. If this be true, it is evident that the fauna of Australia ought to be more nearly allied to that of South Africa than to that of South America, because the connexion with the former by way of India is so much closer than the connexion with the latter by Kamschatka and Alaska. Let us see if this is so.

The Australian Mammalia are very peculiar, and are more closely allied to the Jurassic mammals of Europe and America than to any now living. The marsupials of America are related to the Eocene marsupials of Europe, and are evidently

* Quart. Journ. Geol. Soc. 1876, p. 345.

† 'Palæontology of New Zealand,' part iv. p. 4 (1880).

‡ Such as *Voluta pacifica*, *Triton Spengleri*, *Parmophorus unguis*, *Chione Stutchburyi*, *Tapes intermedia*, *Pectunculus laticostatus*, *Waldheimia lenticularis*, and others.

a younger branch of the family from which the Australian mammals had been separated long previously. Consequently the relationship between the American and Australian marsupials does not militate against Mr. Wallace's theory. The distribution of the birds is decidedly favourable to it. The flycatchers, sun-birds, hornbills, bee-eaters, king-crows, kingfishers, nightjars, swifts, bustards, and other Australian birds are all related to Old-World forms, exceptions perhaps being found in the Megapodes, or mound-builders, which are probably allied to the curassows of Brazil, and also in the brush-tongued parrots, which have their nearest allies in the parrots of South America.

Most of the families of lizards follow the same rule of distribution as the birds; but the Gymnophthalmidæ are not known in North America, although found in Timor, New Guinea, Polynesia, and South America; and of the Iguanidæ (a characteristic South-American family) a very distinct species is found in Fiji, and another is supposed to occur in Australia. With the snakes the case is different. Out of the fourteen families of land-snakes inhabiting the Australian region, no less than four are found in India, Africa, and South America, but not in North America; and another family, the Amblycephalidæ, is found in India, in South America, and doubtfully in New Caledonia, but not in North America, although all, according to Mr. Wallace, must have passed through North America. The freshwater tortoises are found only in Africa, Australia, and South America. The principal genus, however, occurs both in Australia and in South America, but not in Africa. Here, therefore, the distribution is not in accordance with theory.

The affinity between the faunas of Australia and South America is still better shown in the frogs, whose distribution is quite at variance with that of the birds. One family (Pelodryadæ) is confined to these two regions; two others have the same distribution as the families of snakes just mentioned, being absent from North America, while closely allied forms are found in Australia and South America; and a family of tree-frogs, although widely spread and occurring in North America, has the South-American species more closely related to those of Australia than to those of North America.

The marine and most of the freshwater fishes (except *Osteoglossum*, which is found only in Borneo, Queensland, and Brazil), as well as some groups of insects, such as most of the butterflies and stag-beetles, follow the same rule in distribution as the birds; while other groups of insects, such as the Buprestidæ, Longicorn beetles, and the family of Castniidæ among moths, follow the distribution of the frogs.

The distribution of the marine Mollusca of Australia and Polynesia is favourable to Mr. Wallace's theory; but the terrestrial Mollusca, although most nearly allied to those of the Indian archipelago, have strong affinities with the Mollusca of South America, and show no connexion with those of Africa. This is seen in *Trochomorpha*, *Tornatellina*, *Cyclotus*, *Cyclophorus*, and *Helicina*, which are found in Polynesia, Australia, and South America; *Macrocyclis*, in Australia and South America; *Partula* (a characteristic Polynesian genus) is found also in South America; *Placostylus* is allied to *Orthalicus* of Chili, Peru, and the Solomon Islands; and *Vaginulus*, a marine pulmonate, occurs in India, the Philippines, and in South America. This remarkable distribution is very instructive; for as the marine shells of the Indo-Pacific province have been unable during the whole of the Tertiary era to cross from Polynesia to America, it follows that when the ancestors of these land-shells crossed, the physical geography of the region must have been very different from what it is now, for there is no trace of their having passed into South America from the north.

We see, then, that the Australian fauna consists of three elements. The first is typified by the mammals, and is characteristically Australian. The second is typified by the birds, and is more nearly related to African than to American forms. The third is typified by the frogs, and is more nearly related to South America than to any other part of the globe. There is also a fourth element—the antarctic—which I pass over for the present.

Now it is very difficult, or even impossible, to believe that all the groups of semitropical plants and animals which connect Australia, Polynesia, and even the Sandwich Islands with South America have travelled down from the north by the present land-routes, for then we should have to suppose that all had become extinct in North America, and certainly we should expect to find the connexion between Australia and Africa at least as close as it is between Australia and South America, which is not the case. But even if we got over this difficulty, we should still be unable to explain the facts. If, for example, the frogs had passed into South America by the same route as the birds, both would have shown a similarity in their distribution. The assumption that the present frogs are mere relics of a formerly more extended distribution, and that allied groups have become discontinuous through extermination, will not help us; for if all birds were now to become extinct north of the equator, we should still find the avifauna of Australia more nearly related to that of Africa than to that of South America; and it is impossible, by assuming any reasonable amount of extermination, to make the distribution of birds accord with that of the frogs. The lines of migration of frogs must therefore have been different from those of birds. Again, Mr. Wallace himself allows that salt water is almost a complete barrier to the dispersal of frogs *; consequently where frogs could pass birds could pass also; and as the former have passed between Australia and South America, but not the latter, it follows that the two could not have spread together, but each must have pursued a different route at a different time. And as the present shape of the land accounts for the distribution of the birds, the distribution of the frogs must have taken place before the present groups of birds were in existence. But birds of many kinds were abundant in Europe and in America in Eocene times; and as we know that penguins inhabited New Zealand at the same period, it is probable that birds then existed in Australia also. Consequently the South-American migration must have taken place before the Eocene, and cannot be referred to a warm Miocene period. Evidently, therefore, the existence of the South-American element in the Australian fauna and flora requires some explanation which Mr. Wallace's hypothesis does not supply.

It was these considerations, together with the fact that the earthquake-wave of 1868 had proved that the average depth of the South Pacific Ocean was not great, which led me in 1872 to propose the hypothesis that in the Lower Cretaceous period an antarctic continent extended northwards into Polynesia, connecting Australia with South America and, perhaps, with South Africa. I introduced the African connexion solely to account for the distribution of the Struthious birds; but I am now satisfied that Mr. Wallace's explanation of the spread of these birds from the north is more correct; and no reason therefore remains for supposing that Australia was ever connected with Africa. But the evidence of a connexion with South America is stronger than ever. Nevertheless I now abandon the idea of an extensive antarctic continent, because the soundings that have been lately taken in the Pacific Ocean have shown that such a supposition is highly improbable. At the same time these soundings have made it clear how the connexion really took place.

The surveys of the 'Tuscarora,' the 'Gazelle,' and the 'Challenger' have proved that a vast submarine plateau, nowhere more than 2000 fathoms below the sea-level, runs

* 'Geographical Distribution of Animals,' i. p. 416.

from New Guinea and North Australia in an easterly direction through the Fiji and Tonga Islands to Samoa, spreading south to New Zealand and north to the Ellice, Gilbert, Marshal, Caroline, and Pelew Islands. This plateau is split into two portions by a deep narrow channel, which runs between New Zealand and the Kermadec Islands and between New Caledonia and the New Hebrides until it almost reaches Torres Straits. Another submarine plateau, also never more than 2000 fathoms below the sea-level, extends from Chili in a north-west direction to the Society Islands and Cook's Islands, including Juan Fernandez, Easter Island, the Paumotus, and the Marquesas Islands. Between Cook's Islands and the Samoa Islands there is a deep channel, but whether this is continued into the deep sea north of Samoa or whether the two plateaux are continuous is uncertain. Mr. Wild, of the 'Challenger' Expedition, says, "It seems as if an almost uninterrupted area of elevation crossed the whole basin of the Pacific in a north-westerly direction from Patagonia to Japan" *, probably about 1500 fathoms from the surface. North of this plateau the ocean averages 3000 fathoms in depth. To the south it ranges from 2900 to 2600 fathoms, getting gradually shallower towards the south-east. The shallowest part of the plateau is the ridge, already mentioned, between New Zealand and North Australia, which is nowhere more than 1000 fathoms below the surface.

Here we have probably the remains of an ancient continental area, which bridged the South Pacific and allowed the passage of frogs, land-shells, insects, and plants between New Guinea and South America, but which became submerged before the present groups of birds had come into existence. The date of this South-Pacific continent must have been anterior to the marine Indo-Pacific fauna, because hardly any of the fishes, Crustacea, and shells of Polynesia have crossed over to America; and it must have been posterior to the appearance of dicotyledonous plants. Now of the genera of marine shells characteristic of the Indo-Pacific fauna and not found on the American coast, *Turbinella*, *Ricinula*, *Tridacna*, and *Aspergillum* are Miocene; *Rimella*, *Rostellaria*, *Seraphs*, *Dolium*, *Ancillaria*, *Cardilia*, *Pythina*, and *Glaucomya* are Eocene; while *Vulsella* is found in the Upper Cretaceous rocks. A few others, such as *Nautilus*, *Stomatia*, and *Neritopsis*, are old forms apparently dying out. The genus *Monoceros* is also found in the Eocene rocks of Chili, but is not known in the Indo-Pacific province. We cannot therefore

* 'Thalassa,' p. 22.

put the South-Pacific continent later than the Cretaceous period. On the other hand, though fossil plants belonging to the Jurassic period are known from many parts of the world, not a single Dicotyledon has as yet been found among them, the oldest known form being a poplar from the Lower Cretaceous beds of Greenland. In the Upper Cretaceous epoch dicotyledonous plants were abundant in Europe, North America, and in tropical Africa, and each of the three classes Monochlamydeæ, Polypetalæ, and Gamopetalæ were represented. The South-Pacific continent must therefore have existed after the Jurassic, and must have been submerged before the Eocene period.

Let us now see what light the geology of the surrounding countries throws on the subject. To commence with Chili: from Mr. Darwin's 'Observations on the Geology of South America' we learn that the fundamental rock-system of Chili and Western Tierra del Fuego consists of an irregular plateau of mica-schist and gneiss. On this floor immense masses of volcanic rocks, chiefly andesites and diorites, have been poured out from submarine volcanoes, forming the ranges of mountains called the Andes. These mountains are highest in the north, and get lower and lower southwards; but portions of volcanic rocks are found all through to Tierra del Fuego. High up among the volcanic rocks of the Andes in Chili a sedimentary gypseous system occurs, containing fossils of the Lower Cretaceous or perhaps Upper Jurassic period. Fossils of the same age are also found in a clay-slate system forming the eastern side of Tierra del Fuego and stretching far up the eastern flanks of the Andes. These Lower Cretaceous rocks go to a height of 14,000 or 15,000 feet above the sea. On the Atlantic side enormous plains of gravel and silt slope from the sea to an elevation of 8000 feet or more at the base of the mountains. On the Pacific side horizontal strata of probably Eocene age lie on the older rocks, and these are covered in places by gravel-beds, which go to a height of 1300 feet.

From these facts Mr. Darwin infers that during the Jurassic period this part of South America was a deep sea, on the bed of which volcanic eruptions took place. In the Lower Cretaceous it was shallow sea, with land in the neighbourhood, but the bottom was sinking, and it was further depressed for 7000 or 8000 feet, although the volcanic ejections continued to maintain land above the surface of the ocean. In the Upper Cretaceous period upheaval commenced, and, although interrupted by many oscillations, this upheaval has been going on ever since, until the elevation has been as much as

14,000 or 15,000 feet, that is 2500 fathoms. Now it is fair to suppose that when the immense mass of Chili, part of Peru, La Plata, and Patagonia was depressed 2500 fathoms below its present level, a compensating elevation may have occurred in the South Pacific Ocean, and that as South America rose the bed of the Pacific sank. If this were the case, the South-Pacific continent must have been in existence in the Jurassic and Lower Cretaceous periods, and begun to subside in the Upper Cretaceous. The lowest portion, that between Samoa and the Society Islands, would have been submerged first, and the connexion between New Guinea and South America may have been severed before the close of the Cretaceous period. This conclusion agrees very well with that drawn, quite independently, from a study of the Australian fauna and flora.

On the western side of the South Pacific the oscillations of the land appear to have been much less. Of the geology of New Guinea it is known that Jurassic rocks are largely developed both in the north and in the south, which indicates that the land then stood at a lower level. No Cretaceous rocks are known from any part, and at this period therefore it may have been upheaved. Tertiary clays and limestones occur at Hall's Sound and at Yule Island; but as, according to Mr. Tenison-Woods, the fossils have nothing in common with those of Australia, their age remains at present doubtful *.

New Caledonia consists principally of two rock-systems, one of older Palæozoic, the other of older Mesozoic age. According to M. Garnier, Lower Cretaceous rocks are also found there; but the evidence appears to consist of a single fossil (*Pinna*) only.

In Eastern Australia and Tasmania the main range of mountains is formed of contorted schists and slates of Lower Palæozoic age. In New South Wales the denuded surface of these rocks is covered by enormous masses of shales and sandstones of Upper Palæozoic and Lower Mesozoic age, lying in a nearly horizontal position and forming the upper portions of the Blue Mountains. Further to the north, in Queensland, this system is overlain in places by rocks of Jurassic and Cretaceous age. Jurassic rocks are also found in Tasmania, Victoria, and in Western Australia; consequently we must suppose that during this period Australia was more depressed than at present, although not altogether submerged. During

* Mr. C. S. Wilkinson believes them to be of Lower Miocene age (Proc. Linn. Soc. N. S. Wales, vol. i. p. 114). For Mr. Tenison-Woods's opinion see the same publication, vol. vii. p. 382. Formerly he considered them as probably older Pliocene (*l. c.* vol. ii. p. 127).

the whole of the Cretaceous period all Central Australia and the whole of Queensland appear to have been under the ocean, the Rev. J. Tenison-Woods having found Upper Cretaceous rocks on the very summit of the dividing range inland from Brisbane. But Western Australia, New South Wales, Eastern Victoria, and Tasmania remained above water. There are no Tertiary marine rocks on the east coast of Australia, and we must therefore assume that in the Eocene period Queensland was elevated, and from that time neither it nor New South Wales has ever stood much lower than at present. It also appears probable that the centre of the continent remained submerged until the close of the Miocene period or even later. But the geological evidence on this point is at present uncertain, for the "Desert Sandstone," so largely developed in the interior, and which lies unconformably on the Cretaceous system, is thought by Daintree and Clarke to be marine, by Etheridge to be lacustrine, and by Tenison-Woods to be of æolian origin and of different ages. Marine Miocene rocks are found at an elevation of 800 feet above the sea *; but as the central plateau of Australia rises to more than 1000 feet in the north, it would not necessarily be altogether submerged, especially as the northern parts of Australia appear to have been subsiding for a long time. On the other hand, Professor Duncan is of opinion that the Miocene sea of South Australia and Tasmania was of so high a temperature that it must have been open to the influx of warm currents from the north. Be this as it may, it is evident (1) that during the Jurassic and Cretaceous periods Australia stood at a lower level than at present, and (2) that it could not have been joined to New Guinea during the Cretaceous period, as supposed by Mr. Wallace, although this may very probably have occurred during the Eocene period.

Western Australia appears to have been more stable than any other part of the continent. The Darling range consists of granite, capped by sedimentary rocks of Upper Palæozoic age. On the east these ranges end abruptly in cliffs from 200 to 500 feet high, overlooking plains and salt-marshes composed of the "Desert Sandstone." Towards the sea, on the west, the granite disappears, and its place is taken by Upper Palæozoic rocks, which are overlain in places by another system of undoubtedly Jurassic age; and these are again overlain near the coast by æolian rocks of a recent date. Western Australia, therefore, appears to have been a

* C. S. Wilkinson, 'Notes on the Geology of New South Wales,' 1882, p. 57.

land-surface during the whole of the Tertiary and Cretaceous periods, and perhaps it may date back to Triassic times.

The oscillations of land were on a much smaller scale in Australia than in South America, but they were somewhat similar. During the Jurassic and Lower Cretaceous periods both seem to have undergone subsidence; but while in South America elevation commenced in the Upper Cretaceous, in Australia it did not commence until the Eocene. This therefore agrees with, or at any rate in no way contradicts, the conclusion already arrived at, that the South-Pacific continent existed in the Jurassic and Cretaceous periods; but New Guinea, perhaps, was not connected until the Lower Cretaceous.

In the Pacific area itself all we know is that a sedimentary rock containing fossils occurs in the centre of Levuka, one of the Fiji Islands; and, according to Mr. Tenison-Woods, the fossils are of Tertiary, possibly early Tertiary, age, and show a tropical climate*. This is interesting to us as indicating that the South-Pacific continent was broken up in early Tertiary times.

Having thus got some idea of what has probably been going on in the South Pacific, we will now turn our attention to our own country, New Zealand. Sir Joseph Hooker, in the well-known introduction to his 'Flora Novæ Zealandiæ,' published in 1853, divides our flora into five elements:—(1) Australian, (2) S. American, (3) North Temperate, (4) Antarctic, and (5) Polynesian; and he thinks that a land communication, not necessarily continuous, is required to account for the presence of each of these elements, although the different communications may not have been at the same epoch. I do not mean on the present occasion to touch the North Temperate and Antarctic elements further than to show that, on the whole, they are of later origin than the other three, all of which, with few exceptions, are more or less subtropical in character. In my remarks I shall take all my data from Hooker's 'Handbook to the Flora of New Zealand' (1867), because, although many new species have been added since its publication, almost all are endemic and belong to genera already known from New Zealand; and as they are divided in nearly equal proportions between the Australian, South-American, and North Temperate elements, with a few Antarctic forms, their omission will not change in any appreciable degree the relative proportions of the flora of the 'Handbook.'

* Proc. Linn. Soc. of N. S. Wales, vol. iv. p. 358.

Indeed, as Mr. G. M. Thomson has pointed out in his interesting address to the Otago Institute last year, "the general conclusions arrived at in the 'Flora Novæ Zealandiæ' have not been materially altered by recent discoveries" *. For the local distribution of Australian plants, I have Baron von Müller's valuable 'Systematic Census' (1882).

There are in New Zealand 35 subtropical or warm-temperate genera of flowering plants, which are also found in South America, and which probably did not pass from one country to the other by an Antarctic route†, and of these 31 occur also in Australia. These 35 genera contain 74 species, of which 89 per cent. are peculiar to New Zealand. If now we take the subtropical, or warm-temperate, genera, which do *not* occur in South America, we find that there are 33 of them ‡, of which 31 are also found in Australia. These genera contain 96 species, of which 93 per cent. are endemic. There are thus 68 genera which appear to have been introduced from the north, and to these we must add the greater part, at any rate, of the 41 genera which are confined to Australia and New Zealand, for 90 per cent. of the New-Zealand species belonging to these genera are endemic. Mr. Wallace gives a list of 16 of these genera, which, not occurring in tropical Australia, he supposes must have migrated to or from New Zealand across the sea; and he says that nearly all these genera have in their seeds special facilities for transmission. But just as good reasons could be found for showing that many of his tropical genera have equal facilities for transmission; and as 87 per cent. of the New-Zealand species belonging to these 16 genera are endemic, while of the 33 genera named by Mr. Wallace as having come from the north, only 72 per cent. of the species are endemic, we must conclude that the 16 temperate genera have been in New Zealand as long as the 33 subtropical genera. As a matter of fact, 15 out of the 16 are found in Queensland; and it is

* Trans. N. Z. Institute, vol. xiv. p. 486.

† They are *Drimys, Aristotelia, Discaria, Dodonæa, Sophora, Weinmannia, Gunnera, Eugenia, Fuchsia, Passiflora, Sicyos, Eryngium, Oreomyrrhis, Griselinia, Loranthus, Viscum, Lagenophora, Pratia, Myrsine, Sapota, Sebæa, Calceolaria, Gratiola, Vitex, Pisonia, Cassytha, Atherosperma, Peperomia, Piper, Libocedrus, Podocarpus, Libertia, Astelia, Cordyline*, and *Cyperus*. Grasses omitted.

‡ They are *Pittosporum, Melicope, Leptospermum, Metrosideros, Meryta, Coprosma, Stylidium, Cyathodes, Parsonsia, Mitrasacme, Geniostoma, Mazus, Tetranthera, Knightia, Exocarpus, Santalum, Epicarpurus, Elatostemma, Ascarina, Dammara, Dacrydium, Dendrobium, Bolbophyllum, Sarcochilus, Gastrodia, Corysanthes, Microtis, Lyperanthus, Thelymitra, Freycinetia, Dianella, Areca*, and *Gahnia*.

more reasonable to suppose that some of the tropical species have died out in Australia than that all the 16 genera have crossed the sea, an opinion not shared in by Sir J. Hooker, or by Mr. T. Kirk*.

Passing on now to the probably antarctic genera, that is southern genera which have spread east and west in south-temperate latitudes, we find that they number 20†, containing 76 species, of which only 60 per cent. are endemic. Nineteen of the species are also found in Australia or Tasmania, and 11 or 12 in South America. There are also 56 genera of north-temperate plants, which probably spread with the antarctic forms, containing 199 species, of which 67 per cent. are peculiar to New Zealand. The remaining 87 genera I am unable to place. Most of them belong to two or more geographical elements, but others—such as *Fagus* —are doubtful.

Statistical results like these are always open to the objection that the data on which they rest are incomplete and more or less erroneous (for example, *Coriaria* and *Gunnera* may belong to the antarctic element, and *Drosera* to the South-American). They also assume that the rate of variation is equable, which of course cannot be strictly accurate. But this method of investigation has been used with great success in geology, and it can, I think, be trusted here for establishing the two following conclusions:—First, that the northern immigration, taken as a whole, was anterior to the southern immigration, also taken as a whole; and second, that the immigration of the subtropical South-American genera belongs to the first period and not to the last. The first conclusion is similar to that of Mr. Wallace, but arrived at in a different way. The second is opposed to Mr. Wallace's idea that the South-American plants passed through New Zealand and antarctic lands during a warm Miocene period, which is also opposed by the fact that a number of Australian genera are found in South America but not in New Zealand. The fact that very few of our South-American genera are absent from Australia, while a large number of our Australian genera are absent from South America, makes it probable that there have been at least two migrations into New Zealand from the north, and that the South-American element belongs to the first of these only. This is borne out by the distribution of

* See Trans. N. Z. Institute, vol. xi. p. 546.

† I take the following as typical:—*Colobanthus, Oxalis, Acæna, Donatia, Tillæa, Drosera, Apium, Nertera, Abrotanella, Cotula, Forstera, Pernettya, Ourisia, Drapetes, Callixene, Rostkovia, Gaimardia, Carpha, Oreobolus,* and *Uncinia.*

some of the groups. The best example perhaps is the Orchids, of which 18 genera occur in New Zealand. Of these 2 are endemic, and the other 16 are all found in Australia. Two occur also in New Caledonia, three in Polynesia, four in the Indian archipelago, and three in India, while one consists of a single species widely spread over Asia and Australia. None of them are found in South America. The path of the Orchids into New Zealand, by the Indian archipelago and New Caledonia, is thus plainly mapped out, and as none have passed into South America the migration probably took place after the South-Pacific continent had disappeared. The number of New-Zealand species of this order is 38, of which 32 (or 84 per cent.) are endemic, so that the immigration must have been an early one. Other examples are found in Pittosporeæ, Rutaceæ, and Santalaceæ. Examples of the earlier South-American migration are seen in the Monimiaceæ and Chloranthaceæ, while examples of the antarctic migration are the Caryophylleæ, the Geraniaceæ, and the Rutaceæ. It may be objected that the percentage of endemic species is greater in the Australian than in the South-American element, and therefore that the first must be the older. But the objection is not fatal, because, in the first place, we must remember that the American genera would continue to live in Polynesia, and would migrate into New Zealand again with the Australian forms, thus making the percentage nearly the same in each case; and, in the second place, one or two genera may be included in the South-American element which are really antarctic, and this would at once bring down the percentage of endemic species. This is a mistake which could not be made with the Australian genera.

The Kermadec Islands occupy a very important position for furnishing evidence of migrations into New Zealand from the north, but unfortunately very little is known of their flora. What is known shows a remarkable affinity to the flora of New Zealand. Of the 21 species of flowering plants collected by Dr. Macgillivray, only three (14 per cent.) are endemic, 17 are found in New Zealand (one of which is supposed to have been introduced into both places), and the other (*Metrosideros polymorpha*) inhabits Polynesia and New Caledonia. From this we must infer that at a comparatively late period New Zealand extended further to the north-east than at present; for if it had not done so the Kermadec plants would have been far more differentiated from those of New Zealand than they are. At the same time, as but few subtropical species are common to New Zealand and Australia, this land could not have extended far to the north-west; but we may perhaps refer to this period the introduction of several of those tropical species, such as *Avicennia officinalis* and *Sicyos angularis*, which are also found in Australia.

It would thus appear that there have been three migrations of plants from the north into New Zealand: two of very ancient date; the third comparatively recent and comparatively unimportant. The supposition that New Zealand was at one time connected with a South-Pacific continent, from which plants spread into South America and into New Guinea, and that, at a subsequent period, Eastern Australia was attached to New Guinea, and received from thence fragments of this Polynesian flora, together with plants of the Indian archipelago, will explain, I think, why some Polynesian and South-American genera are found in New Zealand but not in Australia, and why some occur in Australia but not in New Zealand.

Passing on now to a consideration of our fauna, we find it composed of the same elements that we recognized in the flora, viz.—(1) Australian, (2) Polynesian, (3) S. American, (4) Antarctic, and (5) North Temperate. The South-American element seems to be the weakest, but until the distribution of our insects, land-mollusca, and land-worms is better known we cannot speak with any confidence on this point. One of our two bats was formerly thought to belong to an American family; but this has been shown to be a mistake, and it now seems that both are of Old-World extraction. This removes a difficulty, for bats are certainly not a more ancient group than birds, and it would have been very puzzling if their distribution had coincided with that of the frogs instead of with that of the birds.

Our birds show only three elements:—(1) an Antarctic, which comprises the penguins, the petrels, three out of five gulls, and four out of nine cormorants; (2) a Polynesian, consisting of the paroquets, *Aplonis*, and the long-tailed cuckoo; and (3) an Australian, which includes all the rest, except a few which are cosmopolitan. Of a South-American element we see no trace except it be in *Nestor*, which may be distantly related to the macaws, although still more nearly to the brush-tongued parrots of Australia and Polynesia. The *Merganser* of the Auckland Islands may represent the North-Temperate element. The affinities of *Turnagra* are still doubtful. I pointed out in 1872* that our land-birds had been derived from the north, and Mr. Wallace has subse-

* Trans. N. Z. Institute, vol. v. pp. 251, 252.

quently, but quite independently, arrived at the same conclusion. While, however, Mr. Wallace thinks that the birds migrated along a land-communication with Northern Australia in the Cretaceous period, I was, and still am, of opinion that the fragmentary nature of our avifauna shows that the land was not continuous, but was interrupted by an arm of the sea between New Caledonia and the mainland, and further, that this communication took place in the Eocene and not in the Cretaceous period. The remarkable fact that both our cuckoos migrate annually to New Zealand from Australia or Polynesia indicates, as I explained in my former paper, a much more recent northern extension of New Zealand, and this agrees with the evidence given by the flora of the Kermadec Islands. Mr. Wallace refuses to believe that these birds migrate, and thinks that they retire to some unexplored parts of the islands in the winter, but unfortunately he gives no hint as to where these unexplored parts are situated.

Our lizards show an Australian element in *Mocoa* and *Hinulia*; but the genus *Naultinus* is endemic and belongs to a group of geckos found in Abyssinia, India, the Indian archipelago, Australia, and Chili. *Sphenodon* belongs to New Zealand only. Our single species of frog has decided South-American affinities.

Of the freshwater fishes *Eleotris* is an Indian-archipelago and Australian genus, but as it is also found in Mexico and the West Indies it may possibly indicate a South-American element; *Galaxias*, *Cheimarrichthys* (an endemic genus allied to *Aphrites*), *Prototroctes*, and the lampreys are Antarctic; while the eels are Australian or Polynesian. The marine fishes are a southward extension of the Indo-Pacific fauna, with a strong Antarctic element in *Bovichthys*, *Notothenia*, *Thersites*, *Gonorhynchus*, *Callorhynchus*, and perhaps in *Genypterus* and others.

The land molluscan fauna appears to consist of Australian, Polynesian, and South-American elements, the latter being marked by *Tornatellina*, *Amphidoxa*, *Cyclotus*, and perhaps *Strobila*. There is no Antarctic element. In my paper on the "Geographical Relations of the New-Zealand Fauna" I stated that the freshwater shells showed a Polynesian affinity distinct from the Australian; but in this I was mistaken, owing to my want of knowledge of the Australian fauna. It now appears that most of the genera are also Australian; but *Melanopsis* is Polynesian, and *Potamopyrgus* is said to occur in South America. The affinities of our freshwater limpet (*Latia*) are not known. The marine Mollusca are, like the marine fishes, a southward extension of the Indo-Pacific fauna with a well-marked Antarctic element, the South-American element being but slightly developed. The main point of interest is the difference exhibited between them and the marine Mollusca of temperate Australia and Tasmania, shown chiefly in the absence from our seas of many common sub-tropical forms. Tasmania, for example, possesses several species of *Conus*, *Cypræa*, *Fasciolaria*, and *Oliva*, of which we have no representatives. We have but one species each of the genera *Mitra*, *Columbella*, and *Nassa*; while Tasmania has respectively 14, 10, and 5 species. We have only 3 species of *Voluta* and 2 of *Marginella*, while Tasmania has 7 of the former and 8 of the latter. This great difference is probably accounted for by the warm south-east current that flows down the coast of Australia, and the cold south-west current that sweeps the shores of New Zealand. If, however, New Zealand was joined to Northern Australia or New Guinea all this would be changed; the warm current would pass down its east coast, while the cold current would be deflected from the west coast of New Zealand to the east coast of Australia. But the difference in the shells was nearly as well marked in Tertiary times as now; consequently we must suppose that New Zealand has been isolated, and that the warm current has passed down the east coast of Australia ever since these genera inhabited the districts. Now *Voluta*, *Mitra*, *Conus*, *Fasciolaria*, and *Cypræa* date from the Upper Cretaceous, the others from the Eocene, and the conclusion seems plain that New Zealand has not been connected with Australia since the Cretaceous period, which agrees well with the inference derived from the fragmentary nature of our avifauna.

The geographical relations of our insects and spiders are not yet known, but as the families of insects in many cases date back to the Jurassic, and several genera to the Cretaceous period, we may expect to find a marked South-American element among them; indeed, Mr. Meyrick has, in papers read to our society, already pointed out that in the Crambidæ the New-Zealand species of *Diptychophora* are more closely related to South-American than to the single Australian species; and that among the Geometrina the genera *Azelina*, *Drepanodes*, and *Siculoides* are South American, while *Tatosoma* is found in Europe, Ceylon, Borneo, Australia, and South America, the New-Zealand species being nearest to those of South America. *Peripatus* is no doubt a very old form; it is found in South Africa, Chili, Central America, and the West Indies, and consequently cannot be considered as representing an Antarctic element, but must be referred to the South-American migration.

It is very remarkable that our crayfishes should belong to the same genus as the species found in Fiji, while those of Australia and South America are generically distinct, although all belonging to the same subfamily. This, I think, proves incontestably that Fiji and New Zealand have had direct land-communication; for Prof. Huxley has pointed out that freshwater crayfishes are very ill adapted for crossing even a narrow arm of the sea. Mr. Wallace thinks that this connexion with Fiji "is hardly probable, or we should find more community between the productions" of the two countries; but when we remember the difference of climate we cannot expect a greater community than actually exists. The marine Crustacea agree with the marine fishes and shells in having well marked Australian and Antarctic elements, but perhaps it is not yet possible to distinguish South-American from Antarctic forms. It will not be necessary to pass in review the lower classes of animals; but little is as yet known of them, and at present they throw no new light on the origin of our fauna.

I will now recapitulate the results we have arrived at about the New-Zealand flora and fauna. The South-American element in the fauna and flora, as shown by the plants, frog, land-mollusca, and insects, proves that New Zealand was closely connected with the South-Pacific continent which probably existed in Jurassic and Lower Cretaceous times, while the distribution of the freshwater crayfishes proves that Fiji and New Zealand have had a continuous land-communication. The distribution of the marine Mollusca shows that New Zealand has been separated from all northern lands ever since the Cretaceous period, and this explains the fragmentary nature of the avifauna. At the same time, the fact that many birds, land-shells, and plants, showing no South-American relations, have passed to New Zealand from the north-west, proves that these islands, although not actually connected, must have extended much further north and approached much more nearly to Queensland and New Guinea at some period in the Tertiary era than they do now, and that that period was an early one is shown by the amount of change that has since taken place in both plants and animals. The flora of the Kermadec Islands, and the remarkable phenomenon of our migratory cuckoos, give evidence of a third north-easterly extension of New Zealand at a much later date; but the absence of many common types of Australian birds, and the small number of northern plants and animals specifically identical with those of Australia, prove that this extension was much less than the other two, and perhaps did not last long. It is now necessary to examine the geology of New Zealand, and see how it bears on the subject.

New Zealand is a mountainous country, partly covered with forests, and difficult to explore geologically, and the fossils, although largely collected, have as yet been but little studied. It is not therefore surprising that many points in its geology remain uncertain, especially as to the ages to be assigned to the several rock-systems of which it is composed, and which, being commonly discontinuous, require the aid of palæontology for their elucidation more than in most countries. Nevertheless, thanks to the energy and skill with which the Geological Survey department has during the last twenty-two years attacked the problem, I think I am safe in saying that the main structure of the country is tolerably well known, especially in those points which alone concern us here, and which I will briefly mention.

The main range forming the New-Zealand Alps in the South Island, and the mountains stretching from Wellington towards the East Cape in the North Island, is composed of highly-inclined sedimentary rocks belonging to four, or perhaps five, distinct systems. The first is probably Archæan or Cambrian. According to Dr. Hector the second is Ordovician, the third Silurian and Lower Devonian, the fourth Upper Devonian and Lower Carboniferous, while the fifth ranges from Permian to Jurassic. This last system contains fossils related to those from the Gondwana system of India and the newer Carbonaceous system of Eastern Australia. According to Mr. S. H. Cox, it is about 21,000 feet in thickness, and is entirely a littoral formation, plant-remains being found all through it; thus implying a subsidence of 3500 fathoms in early Mesozoic times. The axis of the geanticlinal, however, is not in the centre of the range, but lies along its western base, the whole western portion of the elevated mass having been removed by denudation, except in the west part of Nelson and the north part of Auckland. Of the rest, all that remains is the submarine plateau which stretches out towards Australia.

The next system of rocks is of Cretaceous, probably Upper Cretaceous, age*. Along the eastern base of the main range it lies quite unconformably on the Jurassic and older rocks, and, according to Dr. Hector and Dr. von Haast, it is also

* Dr. Hector considers the oldest beds to be the equivalent of the Lower Greensand of England.

found in a similar position on the west coast of the South Island: thus lying at a low level on the geanticlinal axis. In the North Island the geanticlinal axis is covered by thick masses of Tertiary sedimentary and volcanic rocks, which hide the Cretaceous system if it exists there. Evidently a great upheaval, followed by enormous denudation, must have taken place immediately before the deposition of this last rock-system, that is at the close of the Jurassic and commencement of the Cretaceous periods. There may be some doubt as to the exact time of this upheaval, but that the New-Zealand Alps were principally formed during the periods mentioned is unquestionable.

The Cretaceous, or according to Dr. Hector the Cretaceo-Tertiary, system has also been much disturbed in places, and is everywhere denuded, and generally overlain unconformably by beds of Oligocene and Miocene age. This proves that a second elevation, probably of less extent than the first, took place in the Eocene period, and was followed by a second depression in the Oligocene. The Oligocene and Miocene marine rocks are largely developed, and extend to a height of 2500 feet above the sea*, proving conclusively that during this period New Zealand was represented by a cluster of twenty or more islands, on which, as I pointed out in 1872, the various species of moa were probably developed†. Since that time a third elevation has taken place, the proofs of which I must defer to another opportunity. These three elevations agree quite with the conclusions already arrived at by a study of the fauna and flora; and we must suppose that it was during the Upper Jurassic or Lower Cretaceous period that New Zealand was joined to the South-Pacific continent, while during part of the Eocene it extended towards New Caledonia, and again in the Pliocene towards the Kermadec Islands.

Our general results, then, are that in early Mesozoic times New Zealand, Eastern Australia, and India formed one biological region, land probably extending continuously from New Zealand to New South Wales and Tasmania. At the close of the Jurassic period the New-Zealand Alps were upheaved, and the geosynclinal trough between New Zealand and Aus-

* According to Dr. von Haast they ascend to 5000 feet above the sea, but no localities are given ('Geol. of Canterbury and Westland,' 1879, p. 305).

† Mr. Wallace agrees with this opinion, but in his 'Island Life' says that it is a pure hypothesis, of which we have no independent proof; he not, as I suppose, being aware of the distribution of our Miocene rocks, although I mentioned it in my paper (see Trans. N. Z. Inst. vol. v. p. 253).

tralia was formed. During the Lower Cretaceous period a large Pacific continent extended from New Guinea to Chili, sending south from the neighbourhood of Fiji a peninsula that included New Zealand. Nearly all the southern part of America was submerged. Western Australia and Eastern Australia formed two large islands lying at some distance from the continent. This continent supported dicotyledonous and other plants, insects, land shells, frogs, a few lizards, and perhaps snakes and a few birds, but no mammals. In the Upper Cretaceous period New Zealand became separated and reduced to two small islands; the South-Pacific continent divided in the middle between Samoa and the Society Islands, and (the eastern portion being elevated while the centre sank) it ultimately became what we know now as Chili, La Plata, and Patagonia. In the Eocene period elevation commenced in our district; Eastern Australia was joined to New Guinea, which stretched through New Britain to the Solomon Islands. New Zealand was also upheaved and extended towards New Caledonia, but the two lands were divided by an arm of the sea. The mainland of New Guinea had by this time been invaded from the north by a large number of plants, birds, lizards, snakes, &c., which migrated south into Eastern Australia, and a few passed over the New-Caledonia channel and reached New Zealand. But still no mammals. In the Oligocene period New Zealand again gradually sank, carrying with it the sparse flora and fauna it had received, and in Miocene times was reduced to a cluster of islands, Eastern Australia all this time receiving constant additions to its fauna and flora through New Guinea. In the Pliocene period elevation once more took place; New Zealand extended towards the Kermadec Islands, and the continent of Australia was formed; after which subsidence again occurred in the New-Zealand area.

These conclusions are more precise, but are much the same as those at which I arrived in 1872, with the exception that I now substitute a South-Pacific continent from which Australia was isolated, for the Lower Cretaceous Antarctic continent of my former paper. Mr. Wallace's hypothesis of an isolated West-Australian continent on which the characteristic Australian flora and mammalian fauna were developed is fairly satisfactory, but I presume that the Australian birds are not supposed to belong to the West-Australian fauna. A few, such as the ancestors of the honey-suckers and the brush-tongued parrots, may have crossed over the sea from New Guinea to Western Australia, but the mass of the birds are supposed to be East-Australian, to have passed into West

Australia by the north while the continent was being upheaved and its climate still humid, and to have become differentiated since the entire drying up of the interior sea so desiccated the country as once more to isolate West Australia almost as effectually as if it were surrounded by water. But Mr. Wallace does not make this sufficiently clear. When, however, we come to that part of Mr. Wallace's hypothesis which deals with the connexion between Australia and New Zealand we find it to be not so satisfactory. In the first place, the facts of geology are against any connexion having taken place between the two countries at the time supposed. In the second place, the South-American element in the fauna and flora is not separated from the Antarctic element. In the third place, the hypothesis fails to explain the South-American element, except on the supposition of large extensions of land during the warm Miocene period, for which there is no sufficient evidence, and which if it had occurred would have allowed birds as well as frogs and land-shells to pass. And in the fourth place, it ignores altogether the special relation which exists between New Zealand and some of the islands in the Pacific. The hypothesis here proposed is no doubt incomplete, and will be much improved when the palæontology of New Zealand is better known; but it does, I think, give a fairly satisfactory account of the origin of the South-American, Australian, and Polynesian elements in our fauna and flora. The Antarctic and North-Temperate elements still remain for consideration; but so wide a subject cannot be entered upon at the end of an address, and I must postpone all discussions to some future occasion.

XLIX.—*Description of a new Genus of Fossil Fishes from the Lias.* By James W. Davis, F.G.S. &c.

[Plate XVI.]

Genus Lissolepis, Davis.

Class Pisces. Subclass Palæichthyes. Order Ganoidei.
Suborder Acipenseroidei. Family Palæoniscidæ.

Body fusiform; head large; gape wide; jaws elongated, furnished with closely-set uniform enamel-tipped teeth; scales of medium size, rhomboidal, mostly with smooth surface, a few anterior ones with slight furrows, posterior margin serrated;

pectoral fins large and broad; ventral fin smaller; anal fin largest; caudal fin equilobate heterocercal. Notochord persistent.

Lissolepis serratus, Davis.

The specimen of fossil fish which forms the subject of the observations following, presents several peculiar features which render it worthy of careful study. For the most part it is beautifully preserved, the only part wanting being the posterior portion of the dorsal margin of the body along with the dorsal fin. The bones of the head to a large extent, the scales, the pectoral, ventral, anal, and caudal fins remain undisturbed. The entire length between the snout and the extremity of the caudal fin is 8·2 inches; of this length the head occupies 2·6 inches, or about one third the entire length. The greatest depth is between the ventral fin and the dorsal surface, where it is 2·2 inches. The cranial bones are strong, covered with enamel, the surface of which is ornamented with numerous pustulations, somewhat irregular in form. The superior portion of the orbit is well defined and prominent. The orbit is comparatively small, placed about equidistant between the upper jaw and the roof of the cranium, and ·7 inch behind the snout. The jaws are large, capable of wide expansion, and armed with closely-set, sharp, conical teeth, curved slightly inwards, their points capped with enamel. The mandible is 1·6 inch in length; it is slightly expanded in front near the symphysis; its median portion is somewhat attenuated, whilst posteriorly the bone becomes deeper and stronger. The maxilla is large; its posterior portion has been slightly displaced and damaged, and is consequently obscure; but it appears to have had a tolerably wide expansion towards the orbit. The premaxillary bone is ·3 inch in length, and has attached to it a number of teeth similar to those on the maxilla and mandible. The operculum is more or less rounded, except on the anterior margin, which presents a concave outline; attached to its lower surface there is an interopercular bone; it is about one half the size of the operculum, and probably extends to form a connexion with the branchiostegal rays, of which there are some indications below the mandible. A series of clavicular bones extend posteriorly behind the opercula. The lower portion of the external covering of the head is removed, and the scapula, contiguous to the pectoral fin, is exhibited. The operculum is enamelled and covered with punctures; the interoperculum presents similar characters. The frontal and ethmoid bones do not project beyond the premaxillaries; they are strongly coated with ganoine, their surface ornamented with vermiculate ridges.

The surface of the body is covered with thickly-enamelled rhomboidal scales; the scales along the lateral line are larger than those above or below, and largest near the head, where the height of each scale is double the breadth; nearer the tail the scales are more nearly equilateral. They are arranged in rows, with a slightly sigmoidal curvature backwards from the dorsal towards the ventral surface of the fish. The number of scales in each row varies from twenty-eight in the deepest part of the fish to fourteen near the caudal extremity. Along the flank, on each side of the lateral line, the scales are also arranged in rows antero-posteriorly; but this does not hold good for more than four or five rows, the arrangement towards both the dorsal and the ventral aspect being more or less indeterminate. Dorsally the scales are smaller, but in front of the dorsal fin they are higher than broad; on the ventral portion they are broader than the median ones, the height being only about one third the breadth. The posterior margin of each scale is finely serrated, as represented in Pl. XVI. fig. 1 *a*. The surface in the large majority is smooth; a few scales nearest the head are slightly striated with minute furrows. The posterior margin of the scales becomes gradually less serrated towards the caudal extremity, and those behind the anal fin are devoid of serrations and quite smooth. The body-scales extend 1 inch beyond the fork of the tail over its upper lobe; they are irregular in form; those in contact with the fin-rays are much elongated.

The *dorsal fin* is absent, and there is nothing to indicate its exact position. The *pectoral fins* are both preserved in this specimen; they are large, a little more than 1·2 inch in length. There are twenty rays in each, which for a distance of ·5 inch remain simple and unarticulated; beyond that distance the rays bifurcate, and in several instances, if not in all, the bifurcations dichotomize towards the outer margin of the fin. The bifurcated rays are composed of numerous joints, divided by transverse articulations. The anterior rays of the fin are the longest and the strongest; there is no appearance of fulcral rays. The *ventral fins* are situated 1·7 inch behind the pectoral fins. In this specimen the fin is folded and extends along the side of the fish; it is ·9 inch in length. The anterior rays are very strong, and at the base a number of large black enamelled fulcra are situated. The *anal fin* is situated 1·5 inch in front of the tail; it is larger than the pectoral or ventral fins, being 1·3 inch in length. The anterior rays are the longest in this fin as in the others, and along the front of the anterior ray there is a number of strong fulcral scales. The basal portion of each ray is grooved and smooth for about a quarter of an inch, beyond which the rays are articulated at short intervals and dichotomize freely. The *caudal fin* is large, bifurcated, heterocercal, and equally lobed. The vertebral column extends at least an inch beyond the termination of the body into the upper lobe of the tail, and the surface is covered with enamelled scales to an equal distance; from the posterior margin spring sixteen rays, which are articulated and freely dichotomize. The ventral surface of the body from the anal fin to the root of the tail is protected by a series of large enamelled plates, which assume a fulcral aspect near the commencement of the lower lobe. The rays of the lower portion of the fin are stronger than those above, and are 1·6 inch in length. They are articulated at short intervals, and each ray dichotomizes; the external ones begin to divide at about 1 inch from the base, and only divide once, whilst those shorter and nearer the centre of the lobe divide into four, and, in a few cases, into six fine-jointed rays. The margin of the lobe is bordered by a row of small obliquely arranged slender fulcra.

This ichthyolite, as already described, possesses many strongly marked characters, the most prominent being the extremely long jaws and wide gape, the sculptured surface-enamelled plates for the protection of the head, the anteriorly situated orbit, and the well-developed clavicles. The rhombic scales beautifully imbricating, with serrated posterior margins and smooth surface; wide along the lateral line, very narrow ventrally. Pectoral and ventral fins paired, the former very large, composed of frequently-dichotomizing closely-set rays. Single and large anal fin. Heterocercal tail with vertebral prolongation into the upper lobe; the lower lobe, as well as the anal and ventral fins, having a series of fulcral scales along the anterior margin. These characters indicate its relationship to the family Palæoniscidæ, as defined by Dr. Traquair *. Of the twenty-two genera included in this family by that author four have been obtained from the Lias, the remainder occurring in the older strata of the Permian and Carboniferous rocks. The four genera from the Lias are *Centrolepis*, Egerton; *Oxygnathus*, Egerton; *Cosmolepis*, Agassiz; and *Thrissonotus*, Agassiz.

The genus *Thrissonotus* was instituted by Agassiz † for the accommodation of a fossil fish intermediate between *Sauropsis*

* Palæontographical Society, vol. xxxi. (1877).

† Rech. sur les Poissons fossiles, vol. ii. pt. 2, p. 128.

and *Thrissops*, having the dorsal fin situated in the middle of the back and the anal fin extended backwards, as in the latter genus. The specimen was in the collection of Lord Enniskillen, and is now at the museum in Cromwell Road. It is from the Lias at Lyme Regis, and was named *T. Colei*. The specimen has since been figured and fully described by Sir P. Egerton in the 'Decades' of the Geological Survey (decade ix. pl. ii.). The dorsal fin corresponds in position to those of *Oxygnathus*. The scales are comparatively small, more or less rhomboidal in form, ornamented by raised ridges, and with a smooth posterior outline, in this respect differing from the specimen now under description. The anal fin is remarkably extended, measuring 1·75 inch along the base and containing fifty or sixty rays.

The genus *Cosmolepis* was established by Agassiz in MS. for a single specimen in Lord Enniskillen's collection from the Lias of Barrow-on-Soar. The scales resemble those of *Thrissonotus*, except that they are smaller in proportion to the size of the fish, there being about sixty in a dorso-ventral row, and their surface is more thickly ornamented by raised lines of the enamel. The anal fin is extended, though not so far as in *Thrissonotus*. The fin-rays are divided transversely into numerous ossicles. The genus is fully described by Egerton in decade ix. pl. i. of the Geological Survey.

The third genus of the Palæoniscidæ of Traquair occurring in the Liassic formation is *Oxygnathus*, described and illustrated by Sir P. Egerton in the eighth decade of the Geological Survey, pl. ix. It is a long and gracefully slender fish, with numerous small scales ornamented with oblique ridges similar to those of the two genera previously mentioned. The jaws are furnished with numerous small incurved teeth intermixed with larger ones. The most characteristic feature rests in the form of the tail, which is deeply cleft into two lobes, the upper one measuring 3·5 inches in length, the lower one only 2·5, the fish measuring 11 inches from the snout to the fork of the tail. The upper lobe "has a scaly investment from the base to the extremity, below which issues a fringe of innumerable fine rays, with frequent transverse articulations and longitudinal bifurcations: the lower lobe contains about twenty-four rays; of these the strongest occupy the middle of the lobe, those of the upper and lower margins becoming gradually finer as they recede from the centre" (see supplement to decade viii.). The teeth of the genus *Centrolepis*, Egerton (decade ix. pl. v.) are similar to those of *Oxygnathus*. The scales are very thick, their exposed surface covered with coarse rugæ, arranged, not as in the other genera mentioned, in a longitudinal direction, but transversely.

The specimen now described, whilst it agrees in family characteristics with the genera mentioned above, differs considerably in those less important peculiarities which constitute their generic features. In each instance the size and ornamentation of the scales is distinct from this one, and the specimen now described is also more especially divergent from *Thrissonotus* and *Cosmolepis* in the non-extension of the anal fins. There are no intermediate small teeth, as in *Centrolepis* and others; and the deeply forked caudal fin, with its long upper lobe invested to its extremity with scales, is a character which readily distinguishes *Oxygnathus*, and separates this specimen from that genus. Hence there appears to be no alternative but to form a new genus under the title *Lissolepis*, with the specific designation *serratus*.

Locality. Lias, Lyme Regis.

EXPLANATION OF PLATE XVI.

Fig. 1. *Lissolepis serratus*, Davis. Natural size.
Fig. 1 *a*. Scales, enlarged.

L.—*On the Neuroptera collected during the recent Expedition of H.M.S. 'Challenger.'* By W. F. KIRBY, Assistant in Zoological Department, British Museum.

THE Neuroptera collected during the voyage of the 'Challenger' were not very numerous, but included several interesting species. With the exception, however, of a small series from the Philippines, which were sent home in papers, the greater number were destroyed by having been placed in spirit—a means of preserving insects which is just as ill adapted for large-winged insects, like dragonflies, as it is for soft-bodied or hairy insects, which should always be preserved dry.

I have only ventured to describe one new species from Tongatabu.

NEUROPTERA.

ISOPTERA.

Termitidæ.

1. *Termes fatalis* (?).

Termes fatale, Kön. Schrift. Berl. nat. Freunde, iv. p. 1, pl. i. figs. 1–9 (1771).
Termes fatalis, Hag. Linn. Ent. xii. p. 143 (1858).

Philippines.

The head is darker and more deeply impressed in front than in other specimens of *T. fatalis* in the British Museum.

2. *Eutermes fumipennis.*

Termes fumipennis, Walker, List Neur. B. M. iii. p. 525 (1853).

Wellington, New Zealand.

A well-known Australian species.

ODONATA.

Libellulidæ.

LIBELLULINÆ.

3. *Pantala flavescens.*

Libellula flavescens, Fabr. Ent. Syst. Suppl. p. 285 (1798).

Malamani, Philippines, Feb. 1875; Tongatabu, July 1874; Queensland.

An almost cosmopolitan species out of Europe, although its claims to be considered European rest solely upon a single reputed British specimen of very doubtful origin (*cf.* M'Lachlan, Ent. Monthly Mag. xx. p. 256, April 1884).

4. *Neurothemis palliata.*

Polyneura palliata, Ramb. Névr. p. 129 (1842).

Amboina, Oct. 1874; Pasananca, near Zamboanga, Philippines, Feb. 1875.

5. *Neurothemis apicalis.*

Libellula apicalis, Guér. Voy. Coq., Zool. (2) ii. p. 194 (1830).
Polyneura apicalis, Ramb. Névr. p. 127 (1842).

Aru.

6. *Neurothemis elegans.*

Libellula elegans, Guér. Voy. Coq., Zool. (2) ii. p. 194, pl. x. fig. 3 (1830).

Philippines; also Ki Dulan, Sept. 25, 1874.

One specimen from the Philippines exactly agrees with *N. elegans.* A second is reddish brown, nearly to the pterostigma, which is reddish, the tips of the wings and the whole border of the hind wings being hyaline.

The best authorities regard the three forms of *Neurothemis* here mentioned as hardly entitled to the rank of distinct species.

7. *Agrionoptera pectoralis.*

Libellula pectoralis, Brauer, Verh. zool.-bot. Ges. Wien, xvii. p. 19 (1867).

Philippines.

Agrees very fairly with the description, except that Brauer gives 17–19 antecubital and 12 postcubital nervures. This specimen has only 14 antecubitals on both fore wings, and 11 postcubitals on the right fore wing and 12 on the left.

8. *Lepthemis sabina.*

Libellula sabina, Drury, Ill. Ex. Ent. i. pl. xlviii. fig. 4 (1773).

Philippines.

A rather small specimen.

9. *Diplax pacificus.*

Male.—Exp. al. 1 unc. 10 lin.; long. corp. 1 unc. 1½ lin. Wings hyaline, rounded; fore wings rather narrow; hind wings slightly stained with yellow at the base, and considerably expanded between the base and the nodus. Nervures black, pterostigma yellowish brown. Fore wings with 8 antecubital nervures of the costal series and only 7 of the subcostal series, and 7 postcubital nervures of the costal series and 4 of the subcostal before the pterostigma; hind wings with 6 antecubital and 7 postcubital nervures; in the second series only the last 4 of the latter; triangles ordinary, that of the fore wings with the basal side rather shorter than the outer; the dividing line slightly oblique. Body testaceous yellow. Head: middle ocellus red, placed in a deep depression; epicranium emarginate above, vertex convex; clypeus (which is semicircular and with two indentations in front), labrum, and sides of epicranium paler yellow than the rest of the head; prothorax quadrifid, the frontal lobes transverse, each marked with a large black spot, the hinder ones contiguous, being less distinctly separated; mesothorax rather long, with two large black spots in front, almost concealed by the junction with the prothorax; a deep longitudinal depression, with a narrow keel in the middle; the lateral sutures slightly marked with black at two or three points. Abdomen with a longitudinal keel on the back, which is reddish brown beyond the second segment, and marked somewhat irregularly with a series of square spots, chiefly towards the ends of the segments; there is also a dark line on the ventral surface, and a series of 4 or 5 irregular long and partly connected reddish-brown spots on the sides of the middle segments. Legs yellowish, the four hinder ones black above; spines strong; claws very large and slightly bifid.

Anal appendages as long as the two preceding segments, pointed; lower appendages broad and a little shorter.

Tongatabu, July 1874.

Agrionidæ.

Agrioninæ.

10. *Ischnura aurora.*

Agrion (*Ischnura*) *aurora*, Brauer, Verh. zool.-bot. Ges. Wien, xv. p. 510 (1865).

Waihiri, Tahiti, Sept. 1875.

Calopteryginæ.

11. *Vestalis melania.*

Vestalis melania, De Selys, Bull. Acad. Belg. (2) xxxv. p. 474 (1873), (2) xlvii. p. 360 (1879).

Philippines.

The brilliant blue of the male (sometimes shading into greenish, especially towards the base) and the rich purplish violet of the more highly coloured females render this species, which was not previously in the British-Museum collection, one of the most beautiful of the Odonata.

Planipennia.

Myrmeleontidæ.

12. *Myrmeleon variegatus.*

Myrmeleon variegatus, Klug, Symb. Phys. pl. xxxv. fig. 4 (1834).

Common in July and August at St. Vincent and St. Jago, Cape Verdes, along with its larva from the former locality. It was previously known from S. France and Arabia.

LI.—*On the Diptera collected during the recent Expedition of H.M.S. 'Challenger.'* By W. F. Kirby, Assistant in the Zoological Department, British Museum.

The collection of Diptera formed was not very extensive, but contained several interesting species, three of which are here described as new. The capture of a species of Tachininæ, originally described from the Red Sea, in the Cape-Verde Islands is very remarkable.

Stratiomyidæ.

Sarginæ.

1. *Sargus spinigera.*

Xylophagus spiniger, Wied.
Beris Servillei, Macq. Dipt. Exot. i. (1) p. 172, pl. xxi. fig. 1 (1838).

Sydney, May 1874.

Tabanidæ.

Tabaninæ.

2. *Tabanus fulvipes*, var. (?).

Tabanus fulvipes, var.?, Phil. Verh. zool.-bot. Ges. Wien, xv. p. 723 (1865).

Messier Channel, Patagonia, January 1876.

Four female examples of a species allied to *T. magellanicus* and *fulvipes*, Phil. *T. fulvipes*, with which (judging from the description) they may possibly be identical, is a Chilian species.

Pangoninæ.

3. *Chrysops aterrimus.*

Long. corp. 5 lin.

Female.—Inky black, very shining; head, thorax, and the basal half of the antennæ clothed with short black hair; eyes dull black; wings hyaline, but more or less broadly brown along the costa. The brown shade covers the whole costal portion of the wing, from the base as far as the point where the third longitudinal vein branches; it is then continued narrowly along the costa to just beyond the third vein, being distinctly thickened on the second and third veins. The discoidal cell is almost clear, but the fourth submarginal cell is clouded. From the extremity of the discoidal cell, and below the third longitudinal vein, from a point just before the fork, the brown coloration extends around and above the whole of the discoidal cell, almost as far as the posterior intercalary vein, just before which it ceases, although it runs along the anterior intercalary vein almost to the hind margin.

Eucosca Dock, Japan, May 1875.

Allied to various North-American species, such as *C. niger*, Macq., *sepulchralis*, Fabr., *carbonarius*, Walk., &c., from which it is easily distinguished by the different pattern of the wings. The single specimen from Eucosca Dock being damaged, I have described the species from two perfect specimens from Yokohama, collected by Mr. Jonas.

Bombyliidæ.

Anthracinæ.

4. *Anthrax Tantalus.*

Anthrax Tantalus, Fabr. Ent. Syst. iv. p. 260 (1794).

Amboina.

A small specimen, with a brilliant violet iridescence. It most resembles a specimen from Celebes in the British-Museum collection.

5. *Anthrax bombyliformis.*

Anthrax bombyliformis, Macl. King's Surv. Coasts Austr. ii. p. 468 (1827).

Cape York.

Asilidæ.

Dasypogoninæ.

6. *Dasypogon diversipes.*

Length $5\frac{1}{2}$–$7\frac{1}{2}$ lines; expanse 10 lines.

Black; thorax dusted with yellowish white on the borders, with three slightly raised reddish longitudinal lines near the middle, the interspaces being entirely black. Beyond this the front half of the mesothorax is yellowish white (the innermost part being very bristly, which gives it a dusky appearance), but the hinder part is only of this colour on the borders and along a transverse median line. Head yellowish; proboscis, antennæ, and a line on the vertex black; scutellum and halteres yellow, a yellowish spot on each side of the back of the metathorax; under surface of thorax clothed with yellowish hair. Abdomen rather long, black, with conspicuous pale yellow spots, diminishing in size, on the sides of all the segments except the two last near the extremity; under surface clothed with yellowish hair, but less densely than the thorax; coxæ reddish, densely clothed with yellowish-grey hair; femora red, trochanters and tips of knees black; tibiæ yellow, with black bristles, tip broadly black above; tarsi black above and testaceous beneath; basal half of first joint yellow. Wings brownish hyaline, with chestnut-coloured nervures.

Sydney, May 1874.

Laphriinæ.

7. *Laphria consobrina.*

Laphria consobrina, Walk. Journ. Linn. Soc., Zool. iv. p. 84 (1860).

Aru.

Muscidæ Calypteræ.

Tachininæ.

8. *Echinomyia Micado.*

Length 6 inches.

Male.—Superficially resembles *E. fera*, Linn. Head dull yellow; eyes and ocelli red, the latter on a black prominence near the occiput, bounded by the branches of a reddish Y-shaped depression, between which and each eye is a long black oval stripe; antennæ red, club black, spatulate; thorax blue-black above and dull black below; the shoulders and a narrow space at the base of the wings reddish; scutellum more distinctly red. Abdomen reddish, with yellowish shades towards the sides; a blue-black stripe, narrowing behind, on the middle of each segment, but ceasing about the middle of the fourth segment; abdomen beneath dull black in the middle, with each segment edged behind with a yellowish line. Wings dull hyaline, tinged with yellow at the base, the veins yellow except towards the tip, where they are blackish; alulæ ivory-white. Legs reddish; femora black nearly to the tip, especially above; all the bristles black, except the hair on the cheeks, which is partly yellowish; proboscis reddish, partly black in the middle.

Kobé, Japan.

9. *Gonia* (?) *guttata.*

Gonia (?) *guttata*, Walk. Entomologist, v. p. 341 (1871).

St. Vincent, Cape Verdes, July 1873.

Originally described from Tajora (Straits of Bab-el-Mandeb!). The specimen from St. Vincent does not appear to differ from the type.

10. *Masicera prominens* (?).

? *Masicera prominens*, Walk. Journ. Linn. Soc., Zool. v. p. 155 (1861).

Aru.

Muscidæ Acalypteræ.

Micropezinæ.

11. *Calycopteryx Moseleyi.*

Calycopteryx Moseleyi, Eaton, Ent. Month. Mag. xii. p. 59 (1875); Verrall, Phil. Trans. clxviii. p. 239, pl. xiv. figs. 1 *a–e* (1879).

Royal Sound, Graves Island, Kerguelen, Jan. 19, 1874; Heard Island, Feb. 6, 1874.

Ephydrinæ.

12. *Amalopteryx maritima.*

Amalopteryx maritima, Eaton, Ent. Month. Mag. xii. p. 58 (1875); Verrall, Phil. Trans. clxviii. p. 241, pl. xiv. fig. 2 (1879).

Heard Island, Feb. 6, 1874.

Borborinæ.

13. *Anatalanta aptera.*

Anatalanta aptera, Eaton, Ent. Month. Mag. xii. p. 59 (1875); Verrall, Phil. Trans. clxviii. p. 244, pl. xiv. fig. 4 (1879).

Heard Island, Feb. 6, 1874; Betsy Cove, Kerguelen Land, Jan. 10, 1874.

Bibionidæ.

14. *Bibio Marci*, var.

Tipula Marci, Linn. Syst. Nat. ed. x. vol. i. p. 588 (1758).

Eucosca Dock, Japan, May 1875.

The wings appear to be darker and the thorax duller than in European specimens; but I will not venture to separate the Japanese form as a distinct species.

15. *Plecia fulvicollis.*

Penthetria fulvicollis, Wied. Dipt. Exot. p. 31 (1821).

Aru.

LII.—*Coral-soundings in the Solomon Islands.* By H. B. Guppy, M.B., Surgeon H.M.S. 'Lark.'

The following observations were made in different localities of the Solomon group during 1882 and 1883.

1. *Selwyn Bay, on the west side of Ugi Island.*—The

shore-reefs which fringe this island attain their greatest width on the weather or east side, where they receive the brunt of the trade-swell. On the lee side, however, around the shores of Selwyn Bay, corals thrive in considerable profusion; and here my soundings were taken. Out of fourteen casts in depths less than 25 fathoms and more than 5 fathoms, sand was only brought up on the arming on two occasions; whilst out of fifteen casts in depths beyond 25 fathoms and extending to 50 fathoms, there was only one instance, viz. a cast of 26 fathoms, in which sand or gravel was not found on the arming. On examining the results of the four lines of soundings which I took, I am inclined to place the limit of depth at which coral thrives in this bay at between 20 and 25 fathoms. The branching Madrepores and corals of the genus *Seriatopora* appeared from the broken fragments brought up in the arming to have a vertical range extending through the whole zone of coral-growth; the Madrepores, however, apparently lived under more favourable conditions in the shallower water; whilst the *Seriatoporæ* * seemed to prefer the lower limits of the zone. This accords with Mr. Darwin's experience on the leeward coast of Mauritius ('Coral Reefs,' 1842, p. 81).

2. *Port Mary, on the west side of Santa-Anna Island.*—This small island, which lies off the eastern extremity of St. Christoval, is an upraised coral-atoll, about 450 feet in height, and completely girt by shore-reefs which on the west side of the island almost enclose a large circular lagoon known as Port Mary. My soundings were taken off the outer edge of the reef enclosing this harbour. They extended to depths of between 70 and 80 fathoms, and included sixty-three casts. The conclusions to be deduced from the indications given by the arming of the lead may be briefly stated. The most favourable conditions for the growth of coral existed in depths less than 12 fathoms. Down to 20 fathoms living coral flourished, but in less profusion. Beyond that depth sand and gravel were more frequently brought up on the arming, and a depth varying between 20 and 30 fathoms represented the lower limit of the coral-zone. From the absence of *branching* corals, no fragment of living coral was brought up during the soundings. In only one cast was I able to recognize the nature of the coral from the form of the impression, when, from a depth of 17 fathoms, the arming preserved the prints of the large cells of one of the Astræidæ. From experimental observation I have found that in the majority of soundings the unavoidable swaying of the lead renders the

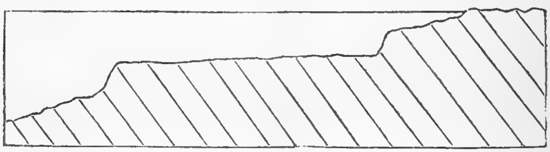
* Probably a new species.

impression difficult to recognize. In section 1, I have shown, drawn on the true scale, the seaward slope of that part of the reef at which the soundings were taken. For the first 100 to 150 yards from the edge of the reef the submarine slope was somewhat gradual until a depth of about 16 fathoms was reached, when, within a distance of two boats' length, the

Sections showing the Seaward Slopes of Reefs in the Solomon group.
(*Drawn on a true scale to the* 100-*fathom line*, $\frac{1}{10}$ *inch*=100 *feet.*)

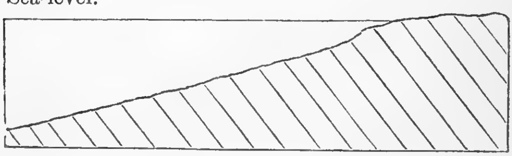
Section 1.—Port-Mary Reef, Santa Anna.

Sea-level.



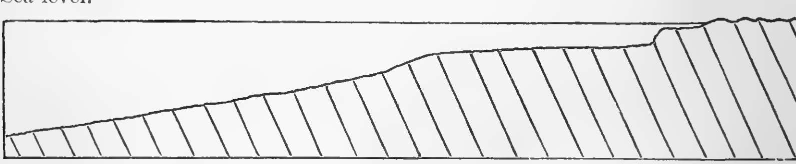
Section 2.—Reef of Onua Islet, Shortland Islands.

Sea-level.



Section 3.—Barrier-reef of Choiseul Bay.

Sea-level.



soundings suddenly increased in depth by about 100 feet, or another 16 fathoms. From the foot of this declivity there was an easy descent for about 450 yards, with a fall of some 50 or 60 feet, terminating in a precipitous slope where there was a drop of about 25 fathoms or 150 feet. The submarine slope beyond descended at a moderate angle to considerable depths. I have, however, terminated this section at the 100-fathom line, having no reliable information of the greater depths. Santa Anna, I should add, rises out of deep water, where 200 fathoms of line have failed to reach the bottom.

3. *The Reef of Onua Islet.*—This islet is one of a group of islets and small islands situated on a broken line of barrier-reef which skirts the weather or south-east border of the Shortland Islands. My soundings were taken off the weather edge of this reef in a 'Rob Roy' canoe, and considerable caution had to be exercised in the shallower depths on account of the uncertain behaviour of the rollers. From a series of soundings between the depths of 6 and 33 fathoms, it would appear that the lower limit at which coral thrives on the sea-ward slope of this reef is about 20 fathoms. Beyond that depth the arming was thickly coated with sand and gravel. Section 2 shows on a true scale the submarine contour of this reef where the soundings were taken. For the first 100 yards from the edge of the reef-flat there was a gradual descent until a depth of 5 or 6 fathoms was reached, when there was a rapid fall of from 10 to 15 fathoms, followed by a moderate slope to the 100-fathom line.

4. *The Harbour of Treasury Island.*—In this harbour, which has a maximum depth reaching down to 46 fathoms, I found the living coral restricted, on account of the rapid descent of the submarine slope, to a narrow zone limited by a depth of from 12 to 15 fathoms. In the more open part of the harbour a calcareous mud, often foraminiferous and occasionally loamy, and derived from the material brought down by the streams, formed the bottom beyond the coral zone; but among the islets in the more sheltered south side of the harbour I found that calcareous gravel derived from the *débris* of corals and shells occurred in the deeper water.

5. *North-west Coast of Balălai Island, Bougainville Straits.*—This low island is of raised coral formation and fringed by shore-reefs. My soundings (over sixty in number) were taken off the north-west coast, which is the lee side of the island during the greater portion of the year. A depth of 15 fathoms apparently represented the lowest limit of the zone of corals. Beyond that depth the arming, in the great majority of the casts, came up thickly coated with calcareous sand and gravel. My soundings showed that extensive thickets of a branching *Porites* (*Porites lævis*, Dana) occurred in the shallower depths of from 2 to 8 fathoms, living fragments frequently breaking off in the arming. This species of coral apparently occupied the region that is usually usurped

on the protected sides of islands by the arborescent Madrepores. The branching coral most frequent in the greater depths was a slender Madrepore, fragments of which, bearing the living polyps, came up in the arming from depths of $9\frac{1}{2}$, 10, and 13 fathoms. I should add that a portion of an Alcyonarian (*Anthelia*), was brought up from $13\frac{1}{2}$ fathoms.

6. *The Barrier-reef of Choiseul Bay.*—This bay lies within a broken line of barrier-reef which skirts the western extremity of the large island of Choiseul, at a distance of from one half to three quarters of a mile from the shore. Basing his observation on Bougainville's chart of this bay, Mr. Darwin inferred (' Coral Reefs,' p. 167, edit. 1842) that part of the shores is fringed by coral-reefs. In reality the reefs have the characters of the barrier class, although associated with shore-reefs to the northward and southward of the bay; and the capacious anchorage with a depth of from 13 to 18 fathoms, which Choiseul Bay affords, owes its existence to the fact of its lying within a line of barrier-reef. The intention of the French navigator to anchor in this harbour was frustrated by an attack made by the natives on his boats whilst employed in searching for an anchorage. For this reason his plan of the harbour was imperfect, and may be viewed as merely a preliminary sketch. My soundings off this barrier-reef gave results somewhat at variance with my previous experiences. I was surprised to find that in fifteen casts between the depths of 3 and 20 fathoms sand or gravel was brought up on the arming on seven occasions, and that six out of fourteen casts in depths between 20 and 40 fathoms gave a similar indication of the bottom. A living fragment of Madrepore was brought up from 13 fathoms. In a cast of 23 fathoms the arming preserved the impression of the cells of one of the Astræidæ, and in another of 31 fathoms there was a rounded impression of the size of a billiard-ball, the inner surface of which retained the prints of small cells as if of a *Porites*. The conclusion at which I arrived after extending my soundings to 40 fathoms, at a distance of about 600 yards from the shore, was that I had not reached the lower limit of the coral-zone. An examination of the configuration of the bottom, as shown in section 3, may throw some light on this unusual experience. With the eye assisted by the lead I could observe that the submarine portion of the reef at first sloped gradually to a depth of 4 or 5 fathoms. There was then a sudden drop of another 9 or 10 fathoms, forming a steep declivity, at the foot of which began a broad platform with a gentle slope down to 25 fathoms, and terminating in another somewhat gradual slope. An inspection of this diagram would lead one to expect that an

accumulation of detritus would be found in depths of from 15 to 20 fathoms at the foot of the declivity, and that in the more level region beyond, from the absence of such accumulations, there would be more favourable conditions for the growth of coral. My soundings afford evidence that such is the disposition of the detritus on the outer slope of this reef. Eight out of twelve casts in depths between 15 and 20 fathoms brought up sand or gravel on the arming; whilst out of eleven casts in depths between 23 and 40 fathoms, seven showed a perfectly clean indentation, in two of which the nature of the coral was shown. There would thus appear in this reef to be a belt of sand and gravel separating the zone of coral into two parts, and situated in those depths in which corals are stated to cease to flourish. I was on the point of concluding that I had found in this band of sand and gravel the lower limit of the corals; but a subsequent extension of my line of soundings seaward prevented my falling into this error.

The question then arises, whether in other reefs there may not be a belt of detritus dividing the coral-zone into two portions. In reefs of which the submarine slope is rapid, or which are exposed to the whole strength of the trade-swell on the weather side of the island, it would be a difficult matter to ascertain the existence of such a belt, as in the former case an accumulation of detritus of small horizontal extent would reach downwards to a great depth; whilst the violence of the surf in the second instance would distribute the sand and gravel over a considerable area. In the somewhat gradual slope of the reef of Choiseul Bay there are more suitable conditions for the formation of such a belt of detritus*.

My observations on the outer slopes of reefs in this group point to the conclusion that the corals grew in greatest profusion in depths under 10 fathoms. Beyond this depth the sloping surface of the reef usually presented the character of extensive tracts of bare coral-rock, studded here and there with bosses of living massive corals, and marked at intervals by small patches of calcareous sand and gravel. In some isolated reefs, sunken some 6 to 8 fathoms below the surface, and only indicated to the navigator by the "rips" produced by the powerful tidal currents of these regions, I was much surprised by their comparatively barren aspect. Lark Shoal, an isolated reef exposed to the full force of the trade-swell in the eastern portion of the Solomon group, is covered by from

* It is worthy of note that in the cases of the soundings off the reefs of Santa Anna and Onua Islet, the lower limit of the coral-zone corresponds with the base of the declivities shown in the sections.

7 to 9 fathoms of water, and offers an instance of this nature. Here I expected to find the corals in luxuriance; but the appearance of its surface from the ship's side and the character of the soundings showed that the greater portion of its area consisted of dead coral-rock dotted with bosses of massive corals here and there. Such was the condition of another shoal in Bougainville Straits, which was covered by from 5 to 6 fathoms of water. Here the eye could discern an occasional dark-coloured boss of coral in a field of a pale grey hue, which was shown by the nature of the crushed material adhering to a heavy lead to be dead coral-rock.

A word with reference to the general character of the reefs in the Solomon group may not be out of place in concluding this paper. From the works of Krusenstern, Surville, Bougainville, and Labillardière, Mr. Darwin presumed that these islands were fringed ('Coral Reefs,' p. 167, edit. 1842). There are, however, numerous reefs in this archipelago which belong to the class of barrier-reefs. A barrier-reef of extensive nature is situated on the west side of Bougainville Straits, where it follows the edge of a wide submarine platform, which may be viewed as the submerged continuation of Bougainville Island. A smaller barrier-reef, previously referred to in the instance of Choiseul Bay, skirts the western extremity of the island of Choiseul on the opposite side of these straits. Similar lines of dangerous reefs lie off portions of the coasts of Guadalcanar, Malayta, and other islands. I hope on some future occasion to enter more fully into this subject, this reference to which must for the present suffice.

LIII.—*On the Relation of the Pali of Corals to the Tentacles.* By Prof. P. Martin Duncan, F.R.S. &c.

Prof. Lindström has brought under my notice that my late friend M. de Pourtalès differed from me in reference to the relation of pali to the tentacles of Corals. In noticing a very interesting form from the Caribbean Sea which has a Miocene ancestry, M. de Pourtalès considered the question of pali. He wrote, "Prof. Duncan's supposition that the office of the pali is to support an extra circle of tentacles is not borne out in this species, nor in any other paliferous coral of which I have had the opportunity of examining the polyp." We had a conversation on this point, and M. de Pourtalès told me that he had not had opportunities of seeing many living forms with pali with the soft parts extended, but that those he had seen had the soft disk supported by the pali. He was then made aware that the supposition did not come within the scope of the word conjecture, and there was no remonstrance whatever on his part, as Prof. Lindström thinks. The so-called supposition was not mine, but that of a man whose admirable and extensive original researches led him beyond the troubles of criticism. Jules Haime's essay on the soft parts of *Cladocora cespitosa** is one of the most interesting and important of his works, and is of great value because he described the soft structures in their natural condition and not after altering them by reagents. It was necessary that I should abstract this essay in my introduction to the "Supplement to the British Fossil Corals," Palæontographical Society, 1866. The translation of the part of the sentence, "coïncide avec la présence des palis situés au dessous et en dedans de ces tentacules," although placed between inverted commas, was mistaken by my friend as my own opinion and the result of my own work.

There was no supposition, but a definite statement of a fact by a naturalist who was as well able to judge the truth as any subsequent investigators.

Whilst I was preparing the monograph just alluded to, Mr. Peach was good enough to watch and draw some specimens of *Caryophyllia clavus*, var. *borealis*, and to send me his finished delineations and descriptions. The lithographs on plate ii. Monogr. Brit. Foss. Corals, pt. i. 1866, figs. 9–20, are correct reproductions of nature. He was convinced, as I was and still am, that the inner row of tentacles of figs. 9 and 11 relate to the pali in the manner *seen* by Jules Haime in *Cladocora*.

May 1884.

LIV.—*On some Hydrocorallinæ from Alaska and California.* By W. H. Dall†.

The descriptions herewith, with one exception, are of species from an area from which none have hitherto been described‡.

* Hist. Nat. des Corall. vol. ii. p. 591.

† From a separate impression from the 'Proceedings of the Biological Society of Washington,' vol. ii. 1883–84. Communicated by the Author, having been read March 22, 1884.

‡ A *Stylaster rosso-americanus*, Brandt, has been mentioned (Z. wiss. Zool. xxii. p. 292), but has never been described or figured. It may be an additional species.

They are closely allied to species found in the Oregonian and Californian province described by Prof. Verrill, but have been, by his kind assistance, compared with his types, and appear to him and to myself to be distinct species, differing not only in habit and form, as well as relative size of the calyces, but especially in the sculpture and texture of the surface of the corallum. It is quite probable that the other species may hereafter be found in South-eastern Alaska, in which case the fauna would comprise:—

Allopora venusta, Verrill; *Allopora Verrillii*, Dall; *Allopora californica*, Verrill; *Allopora Moseleyi*, Dall; *Allopora papillosa*, Dall.

To complete the list of Alaskan coralloid animals, *Calligorgia compressa* of Verrill may be added, as found in the Aleutian Islands, the only representative of the sea-fans yet known from the region, which is, however, extremely rich in Sertularian Hydroids.

Allopora Verrillii, n. s.

Cœnosteum thin, reptate, whitish to pale rose-pink, solid, incrusting; with a smoothish irregularly lumpy surface, pretty regularly dotted with sporadic calyces, composed of circular gastropores, each surrounded by a circle of from five to nine dactylopores, with occasional sac-shaped ampullæ, which are most abundant on the most elevated projections of the surface and almost entirely absent from depressed parts. Diameter of the dactyloporic circle about 1·0 millim., of the central gastropore about 0·37 millim.; the distance from centre to centre of the calyces varies from 1·5 to 2·5 millim.

Gastropores cup-shaped, shallow (0·25–0·50 millim.), smooth inside, with the tip of a white spiculose nipple-shaped or roundly conical style in the bottom of each, projecting about its own diameter or less into the cup through the aperture of a long, nearly vertical, conical tube, which it occupies and closely fills. The length of this style, which resembles a fox's brush, is nearly equal to the thickness of the cœnosteum. The margin of the cup in fully developed gastropores is simple and entire, and depressed slightly below (or in no case elevated above) the general surface. In immature calyces there is frequently a shallow groove running from the innermost point of each dactylopore toward or into the gastropore.

Dactylopores variable in number, eight seeming to be the normal, but seven the most common number, never sporadic, in well-developed calyces entirely separated from the cavity of the gastropore throughout their extent; in immature ones joined to it by a shallow superficial groove. Transverse section a little ovoid, the wider arch away from the gastropore, and marked by a vertical, narrow, spongy lamina forming the style. The exterior margin simple, not elevated above the general surface, but rather slightly depressed below it. Neither sort of pore shows tabulæ. Ampullæ simple, sac-shaped cavities as large as or larger than the calyces, not protruding above the general surface, but more numerous on the prominences of the crust.

General surface between the above-described openings impervious, nearly smooth, with the vermicular fine reticulations of the cœnosteum structure showing through the translucent substance, and giving the surface a granular look, a vertical section of the crust looking much the same. Soft parts unknown. Crust growing several inches in diameter, and rarely more than three-eighths of an inch in thickness, generally found on dead shells of *Modiola* or pieces of Nullipore from deep water.

Habitat. Thrown up on beach of Chika Islands, Akutan Pass, Aleutian Islands, near Unalashka. Five specimens collected May 1872 by W. H. Dall. Catalogue number, U. S. Nat. Museum, 4193.

Allopora Moseleyi, n. s.

Cœnosteum thick, nodulous, or indistinctly branched, rosy pink, solid, with an irregular vesicular surface with sporadically distributed protuberant calyces, consisting of subcircular gastropores, deeply vertically grooved near their margins by from seven to twelve dactylopores, whose cavities are continuous with the cavity of the gastropore. Ampullæ not observed. Diameter of the dactyloporic circle about 1·5 millim.; of the gastropore proper 0·75 millim. Gastropores rather deeply (0·50–0·75 millim.) cup-shaped, with the inner surface spiculose; style as in the preceding; margin of the pore deeply indented by the dactylopores, which are usually nine in number, but appear to be normally twelve; the whole calyx projecting, nipple-like, about 0·5–0·6 millim. from the general surface; recalling, in form, a small contracted *Zoanthus*. A spiculose lamellar style appears in the depth of each dactyloporic groove on careful search. The grooves appear to remain always open.

General surface impervious, covered between the raised calyces by small irregular sparse vesicular projections of the cœnosteum, otherwise in appearance and compactness much as in the previously mentioned form. Soft parts unknown.

Habitat. Kyska Harbour, Kyska Island, in the Western Aleutians; one specimen on the beach growing in a cavity between the layers of a mass of Nullipore, collected July 1873, by W. H. Dall. Museum number 6851.

Allopora papillosa, n. s.

Cœnosteum very thin, incrusting, livid madder-pink or brown, with a regularly papillose surface, with close-set sporadic calyces composed of deep cylindrical gastropores vertically grooved for from three to six dactylopores, which are wholly continuous with the cavity of the gastropore. Ampullæ not noticed. Diameter of the calyx about 0·5 millim., of the gastropore proper about 0·35 millim.; average distance between the calyces 0·7–1·3 millim.

Gastropores deep, cylindrical, with a short, hardly perceptible style, which comes into the bottom of the gastropore; but, as a vertical section shows, not vertically but obliquely from one side. Inner surface nearly smooth, a narrow elevated ridge bounding the margin of the combined gastropores and dactylopores.

Dactyloporic grooves rather shallow, long, each with an evanescent trace of a style on the outer wall; six seems to be the normal number to each calyx.

General surface spiculose or finely granulated with small, pointed granules, with regularly-shaped, elevated, uniform papillæ standing in the spaces between the pore-margins, and rising to about the same height, but absent on the immature growing margin of the colony.

Cœnosteum less vesicular than in the previously described forms. Soft parts unknown.

Habitat. On the outside of a living *Mytilus californianus*, from 6 fathoms, Coal Harbour, Unga Island, Shumagin Islands; collected October 1874, by W. H. Dall. Museum number 6852.

Errina Pourtalesii, n. s.

Cœnosteum of a saccharine structure, rising in stout, subcylindrical, rather round-pointed, occasionally branching stems 10 to 50 millim. high (possibly much larger at times), and 8 or more in diameter; colour, when fresh, deep rose-red, bleaching to white or grey in dead specimens; surface loosely granular, becoming lighter coloured and more compact inward toward the central axis; gastropores disposed in irregular lines, which, in the specimen in hand, have a tendency to run from the base spirally to the left, around the column, but are so crowded that little of the surface is free from the nariform hoods of the attendant dactylopores; the gastropores average 0·25 millim. apart, but are rather irregular and occasionally sporadic; a rounded, rather smooth-topped style fills the pore nearly to the brim; the dactylopores are arranged alternately on opposite sides of the row of gastropores opposite the intervals between the latter, though sometimes crowded out of regularity; they are furnished with subtubular projections, squarely truncated at the top and open toward the gastropores, rising above the general surface to about 0·5 millim. or more; when perfect the styles rise nearly to the summit of the enclosing hood, slender, pointed, and rather feathery; two thirds of their length, in general, is above the surface, and the depth of the gastropores is seldom greater (as a rule less) than that of the submerged portion of the others. Ampullæ on the surface, barely covered by a network of cœnosteal granules, which are often broken away, leaving shallow open cups between the projecting hoods; there are no scales, and the circular margin of the gastropores is smooth and simple.

Soft parts unknown.

Habitat. In 50–100 fathoms about the Farallones Islands, off the coast of California, on stones which are frequently brought up on the fishermen's hooks entangled in the corals. A large stone with several specimens upon it was obtained by Count Pourtalès in 1873, and is now in the Museum of Comparative Zoology at Cambridge, from which the specimen described was selected; other specimens are in the collection of the California Academy of Sciences. This coral, as well as *Allopora venusta* and *A. californica*, Verrill, meet with a ready sale in San Francisco, owing to their beautiful colour, which, however, is not lasting if the specimens be much exposed to the light. The present species seems to do a good deal toward bridging the gap between *Errina* and *Distichopora*, as defined by Moseley. Museum number 6853.

I may add, in conclusion, that through the kind co-operation of Prof. G. O. Sars and Miss Birgithe Esmark, I have been enabled to compare the Alaskan and Norwegian Alloporas, which, however, do not present any very marked points of resemblance outside of the generic characters.

LV.—*Descriptions of Palæozoic Corals in the Collections of the British Museum (Nat. Hist.).*—No. I. By Robert Etheridge, Jun., and Arthur H. Foord, F.G.S.

[Plate XVII.]

Favositella, gen. nov.

Gen. char. Corallum of irregular form, concavo-convex, thin; attached to some foreign body; composed of minute rounded or subpolygonal contiguous corallites, which are of two kinds, large and small; the latter distributed over the surface in clusters, raised slightly above the general level. Walls lamellar, distinct. Tabulæ in the larger cells somewhat remote, horizontal, slightly curved, with the convexity downwards; more numerous in the smaller ones. Mural pores few in number, large, irregularly distributed. Base covered with a concentrically striated epitheca.

Obs. In all its external characters this form bears a marked resemblance to some of the genera of the Monticuliporidæ, and until microscopical sections of it had been examined it was unhesitatingly referred to that group. The presence of mural pores, however, points clearly to its Favositoid affinities, while from all the known genera of the Favositidæ it is distinguished by the monticulose character of its surface and the dimorphic structure of its tubes. As regards the perforation of the walls in *Favositella*, a character which excludes it from the Monticuliporidæ, it is true that Mr. E. O. Ulrich * (who has given much attention to that group) states that he has detected mural pores in a "single specimen of an undoubted Monticuliporoid species," viz. *Homotrypa curvata*, Ulrich; but, granting that they do occur in this one species, it may be confidently affirmed that out of hundreds of sections of Monticuliporoid species which have been examined by Dr. Nicholson, Mr. Ulrich, and one of the writers of this paper, no such structures have been seen in any other form. If *Homotrypa curvata* does possess mural pores, then the proper course is to remove it from the Monticuliporidæ and place it in the Favositidæ, where also *Stenopora* finds its appropriate position, and not in the Monticuliporidæ, according to Mr. Ulrich's amended classification of that group †. In brief, *Favositella* differs from all other genera of the Favositidæ in

* Journ. Cincinnati Soc. Nat. Hist., "American Palæozoic Bryozoa," vol. v. p. 124 (1882).
† *Loc. cit.* p. 153.

the minuteness and dual character of its corallites and in its monticulose surface. From the Monticuliporidæ it is separated by the possession of mural pores.

We are acquainted at present with only one species. This has been quite inadequately described, though well figured, by Quenstedt (whose specimens came from Dudley) under the name of *Favosites interpunctus.*

Favositella interpuncta, Quenst. sp. (Pl. XVII. figs. 1–1*f*.)

Favosites interpunctus, Quenstedt, Petref. Deutschl. 1881, Abth. i. p. 10, t. 143. f. 9.

Sp. char. Corallum of medium size, the largest measuring about 7 centim. in its greatest diameter and about 10 millim. in its greatest thickness, usually elongate, sometimes nearly circular, concavo-convex, rising above into irregularly rounded or lobate elevations, with thin slightly expanded margins. Base shallowly concave, covered with a concentrically wrinkled epitheca; usually attached to a shell or other foreign body, which seems, at least in some cases, to have governed the form assumed by the corallum. The thin margins of the latter are sometimes contracted or folded inwards towards the object of attachment, so that their outline exhibits an irregularly sinuous appearance. The tubes which compose the corallum are so minute as to be barely distinguishable, excepting in well-preserved specimens, without the aid of a lens; they open upon the upper surface, the small tubes forming groups about 5 millim. apart, elevated a little above the general level of the surface, so as to constitute faintly defined monticules. The corallites, as seen in tangential sections, are irregularly rounded or subpolygonal in outline, with thick walls. The smaller ones are intercalated at the angles of junction of those of larger size. The latter measure about one half, the former from about one tenth to one fifth of a millimetre in diameter. Longitudinal sections exhibit great irregularity in the walls of the corallites; these are crinkled, with here and there a minute septum-like projection of the wall. The tabulæ of the larger tubes are very delicate, horizontal, or a little oblique, and slightly curved, and placed at from one to two tube-diameters apart. In the smaller cells the tabulæ are more numerous and are thickened with a fibrous layer of sclerenchyma. Mural pores of a large size, remote and irregularly disposed, are seen in these sections.

Obs. The species above described occurs abundantly in the Wenlock Shales at Dudley, Worcestershire, associated with the characteristic fossils of that formation. In some specimens the mural pores have been filled with chalcedony of a concentric structure. It may be noted that the pores are so large as to be seen on a polished surface with a hand-lens.

Locality and Horizon. Dudley, Wenlock Limestone.

Collection. British Museum (Natural History), and A. H. Foord.

Genus Chætetes, Fischer, 1837.

Chætetes Lonsdalei, Eth. & Foord. (Pl. XVII. figs. 2–2 *c*.)

Sp. char. Corallum incrusting in the young state, probably forming large masses in a more advanced stage of growth, of undeterminable dimensions, composed of minute closely contiguous corallites, of which three or four, according as they are measured in conformity with their longer or shorter diameter, occupy the space of 1 millim. Calices polygonal, very irregular in outline, with from one to four tooth-like projections characteristic of *Chætetes*. Tabulæ numerous, complete, horizontal, or slightly arched, usually about one tube-diameter apart.

Obs. So far as we are aware, no species of *Chætetes* has been described hitherto from the Devonian rocks of Devonshire, as the *Chætetes tumidus* mentioned by Mr. T. M. Hall from the Pilton beds of Braunton (Quart. Journ. Geol. Soc. 1861, xxiii. p. 376), if correctly determined, is now known to be a Monticuliporid. We have the present species in the young state incrusting a Cyathophylloid coral, and there is evidence to show that at a more advanced age it became massive and probably lobate. The largest specimen, which is a polished fragment, measures $8\frac{1}{2}$ centim. in its greatest, by about 6 centim. in its smallest diameter. This species is distinguished from all others known to the writers, except *C. depressa*, Fleming, sp., by the minuteness of its corallites, and from the latter by the numerous septum-like projections of its calices and the greater irregularity of the corallites. The so-called "septal teeth" in *Chætetes* are now known to be due, as originally pointed out by Lonsdale, to "fission taking place in the older corallites" (*vide* Journ. Linn. Soc. vol. xiii., Nich. & Eth., jun., "On the Genus *Alveolites*," &c. p. 353, 1877). It becomes therefore a question whether such a character can be used as a means of specific separation, unless, indeed, the degree of fissiparity differs in various species. Under the circumstances it will be better to say that the form now before us differs from its nearest ally *C. depressa*, Flem., sp., in the greater irregularity of its corallites.

Many Devonian Corals have been referred to the genus *Chætetes*, but in most cases these have been shown to belong to other genera. In concluding his notice of *Chætetes* Prof. H. A. Nicholson remarked, "The species . . . . are not known to occur out of the Carboniferous (and possibly the Devonian) rocks" ('Tabulate Corals,' 1879, p. 266). There are, however, a few forms which should be referred to in passing; for instance, in 1851, Messrs. Edwards and Haime described their *C. Trigeri* (Mon. Polyp. Foss. Terr. Pal. p. 269, t. xvii. fig. 6), which from the description appears to belong perhaps to the genus. Mr. A. Winchell has likewise described (Report Geol. & Industrial Resources of the Peninsula of Michigan, 1866, pp. 89, 90) two species under the names of *C. hamiltonensis* and *C. microscopicus*. In the first, the septa are said to be "complete," and we should therefore doubt its reference to the present genus at all; whilst the description of the second is, lacking a figure, too brief for identification.

The Devonian rocks of Muscatine, Iowa, have yielded to the researches of Dr. C. A. White an exceedingly fine form, *C. muscatinensis*, White, of which we have examined specimens; and although in many respects resembling a *Chætetes*, we do not feel justified in at once pronouncing it to belong to that genus. Lastly, Prof. F. von Römer has recently described (Lethæa Geogn. 1883, i. Th. p. 459) a coral from the Devonian rocks of the Eifel, as *C. stromatoporoides*. This is clearly distinct from our species, and, in fact, the author appears to doubt its reference to *Chætetes* at all.

We have much pleasure in associating with this coral the name of the late Mr. W. Lonsdale, who may be said to have laid the foundation for the study of British Devonian Corals, and for that of the genus *Chætetes* in particular.

Loc. and Horizon. Bishop's Teignton, near Torquay, and Torquay, S. Devon.

Collection. British Museum (Natural History), presented by Messrs. A. Rogers and E. B. Luxmore.

EXPLANATION OF PLATE.

Fig. 1. *Favositella interpuncta*, Quenst., sp. Specimen showing lobate form of the corallum. About $\frac{3}{4}$ natural size. Coll. Foord.

Fig. 1 *a*. Another specimen, drawn to the same scale. Coll. Brit. Mus. (Nat. Hist.)

Fig. 1 *b*. Under surface of the preceding, showing the wrinkled epitheca. Attached to a *Bellerophon*?

Fig. 1 *c*. Tangential section of this species. Enlarged about 15 diameters.

Fig. 1 *d*. A single cell, enlarged about 50 diameters.

Fig. 1 *e*. Longitudinal section, showing pores. Enlarged about 15 diameters.

Fig. 1 *f.* Portion of a longitudinal section, showing one of the small tubes between two larger ones. Enlarged about 15 diameters.
Fig. 2. *Chætetes Lonsdalei*, Eth. & Foord. Small polished specimen, showing this species incrusting a Cyathophylloid Coral. Nat. size. Coll. Brit. Mus. (Nat. Hist.).
Fig. 2 *a.* Tangential section, showing septum-like teeth. Enlarged about 15 diameters.
Fig. 2 *b.* A few cells, enlarged about 50 diameters. In this figure the walls of the corallites are represented with somewhat too regular and curved an outline. Their true character is best seen in fig. 2 *a.*
Fig. 2 *c.* Longitudinal section, enlarged about 15 diameters.

LVI.—*On the Orthoptera collected during the recent Expedition of H.M.S. 'Challenger.'* By W. F. Kirby, Assistant in the Zoological Department, British Museum.

The present paper includes only the families Blattidæ, Mantidæ, Phasmidæ, and Gryllidæ. One species of Phasmidæ is here described as new.

Cursoria.

Blattidæ.

1. *Panchlora indica.*

Blatta indica, Fabr. Syst. Ent. p. 272 (1775).

San Jago, Cape Verdes, Aug. 10, 1873.

2. *Panchlora viridis.*

Blatta viridis, Fabr. Syst. Ent. p. 272 (1775).

Bahia, Sept. 1873.

3. *Panchlora maderæ.*

Blatta maderæ, Fabr. Spec. Ins. i. p. 341 (1781).

St. Vincent, Cape Verdes, July 1873.

4. *Epilampra laticollis.*

Epilampra laticollis, Walk. Cat. Blatt. B. M. p. 203 (1868).

Queensland (three specimens).

The type is from Richmond River. The species is allied to *E. notabilis*, Walk., but is larger and paler. The latter species is probably synonymous with *E. inquinata*, Stål.

5. *Polyzosteria ligata.*

Polyzosteria ligata, Watt. Syst. Blatt. p. 220 (1865).

Somerset, Torres Straits, Sept. 1874.

Gressoria.

Mantidæ.

6. *Mantis hybrida.*

Mantis hybrida, Burm. Handb. Ent. ii. p. 536 (1839).

Ki Dulan, Sept. 25, 1874.

Agrees with a specimen from Borneo in the British Museum.

Phasmidæ.

7. *Lopaphus cocophages.*

Alopus cocophages, Newp. Phil. Trans. 1844, p. 288, pl. xiv. fig. 4.

Tongatabu.

Common in the Pacific Islands, and very destructive to cocoanut-trees.

8. *Cyphocrania gigas.*

Gryllus gigas, Linn. Syst. Nat. ed. x. vol. i. p. 425 (1758).

Amboina, October.

9. *Cyphocrania maculata.*

Mantis maculata, Oliv. Enc. Méth. vii. pp. 626 & 636 (1791).

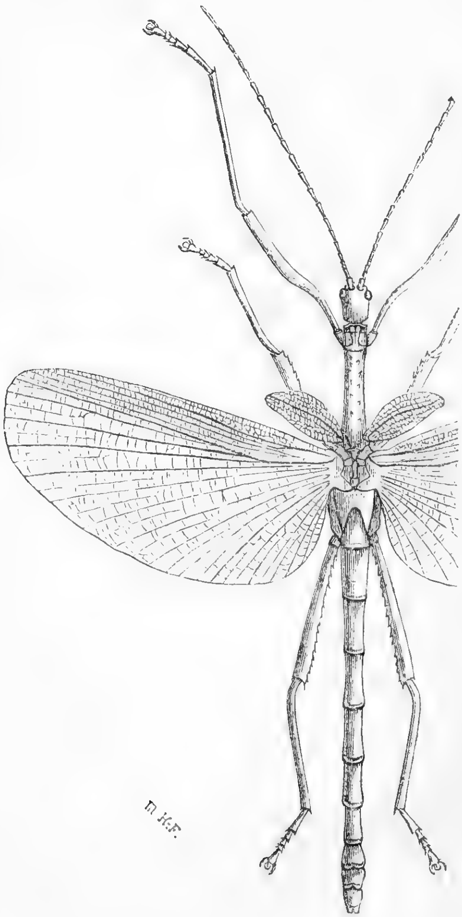
Amboina, October.

The male was not previously in the British-Museum collection.

10. *Necroscia moderata.*

Long. corp. 3 unc. 2 lin.; exp. al. 3 unc. 5 lin.

Male.—Straw-coloured (perhaps greenish during life); wings transparent, with yellow nervures; body moderately stout, of nearly uniform thickness. Head large, oblong, smooth, with a slight indentation on the median line behind; antennæ moderately long and darkening into reddish brown towards the tip; ocelli obsolete. Head and prothorax rather wider than the front of the mesothorax; prothorax unarmed, but with channels on the back, as shown in the woodcut; mesothorax four times as long as the prothorax, expanded behind and with a double row of short spines on the back, five or six on each side, but unsymmetrically, those on the right side being



generally placed more forward than on the left; metathorax moderately short and broad; tegmina oval, concolorous with the costal area of the wings, the abdomen, the legs, and thorax being rather darker. Wings broad, moderately long; legs mostly unarmed; femora with three small serrated ridges, the teeth on the front pair being nearly obsolete.

This species appears to differ from any previously known in the armature of the thorax.

Amboina.

Saltatoria.

Gryllidæ.

11. *Gryllus capensis.*

Acheta capensis, Fabr. Syst. Ent. p. 281 (1775).

St. Vincent, Cape Verdes, July 1873; Green Mountain, Ascension, April 1876.

12. *Anastostoma australasiæ.*

Anastostoma australasiæ, Gray, Mag. Nat. Hist. (2) i. p. 143, fig. 16 (1837).

Somerset, Torres Straits, Sept. 1874.

A single immature specimen.

LVII.—*Description of an African Species of the Coleopterous Genus* Helota, *MacLeay.* By A. Sidney Olliff.

The species I am about to describe was collected by the late Dr. Welwitsch at Angola, and was recently received by Mr. Martin Jacoby in a box, containing chiefly Phytophagous Coleoptera, from Signor Paulino d'Oliveira, of Coimbra, in Portugal. I have elsewhere pointed out (Cist. Ent. iii. p. 49) that all the previously known species of the genus *Helota* are found in Eastern Asia, and therefore the species here described is of special interest, as showing that the genus is of far wider range than could have been anticipated. Lord Walsingham informs me that he has received from Bathurst, West Africa, a new species of *Deuterocopus*, Zeller (belonging to the Lepidopterous family Pterophoridæ), a genus which, up to the present time, has only been known from Java.

This appears to be a somewhat similar and equally unexpected case of geographical distribution.

Helota africana, sp. n.

Elongate, depressed, narrowed both in front and behind, pale fulvous, shining; the head, disk of the prothorax, a spot near the base, and the apical half of each elytron black.

The head rather broad, slightly convex, strongly and not very closely punctured in the middle, the punctures much finer and closer near the sides; epistoma rounded in front, finely and closely punctured; mandibles black and very finely punctured. Antennæ reddish testaceous, the club pitchy black and covered with fine grey pubescence. Prothorax considerably narrowed towards the apex, moderately convex; the disk black, highly polished, strongly and sparingly punctured; the sides fulvous and finely punctured; the large punctures are arranged in two longitudinal irregular patches extending throughout the whole length of the prothorax, one on each side of the middle; anterior margin bisinuate, the angles very slightly produced; sides oblique; posterior margin very strongly bisinuate, the angles acute. Scutellum transverse, black and impunctate. Elytra about half as long again as the head and prothorax together, as broad at the base as the prothorax, slightly narrowed posteriorly, moderately strongly punctate-striate, the seventh interstice somewhat raised, the others rather broad, flat, and impunctate; each elytron with an elongate spot near the base between the third and fourth striæ and the apical half black, the latter with a slight tinge of greenish bronze; humeral angles not very prominent. Underside fulvous and impunctate; head black, finely and closely punctured behind the eyes; the mentum very sparingly punctured; prosternum with an obscure black patch on each side extending from just behind the anterior margin to the middle. Legs fulvous; the coxæ, knees, tips of the tibiæ, and the tarsi pitchy black. Length 13 millim., greatest width 4 millim.

Angola, West Africa (*Welwitsch*). Type in Lisbon Museum.

This pretty species is one of the most distinct of all the described species of the genus. In form it appears to approach *Helota Servillei*, Hope, but differs not only in the absence of the flavous callosities so conspicuous in that species, but also in having the prothorax comparatively shorter and the elytra less produced at the apex. In coloration it is quite unlike any species with which I am acquainted, but, on account of the absence of the flavous callosities and the apical half of the elytra being black tinged with green, it bears some slight resemblance to *H. semifulva*, Rits., with which species in other respects it has little in common.

Mr. C. O. Waterhouse proposes to figure *H. africana* and *H. semifulva* in an early number of his 'Aid to the Identification of Insects.'

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.

March 22, 1884.—Prof. T. G. Bonney, D.Sc., F.R.S., President, in the Chair.

The following communications were read:—

1. "On *Rhytidosteus capensis*, Owen, a Labyrinthodont Amphibian from the Trias of the Cape of Good Hope." By Sir Richard Owen, K.C.B., F.R.S., F.G.S.

The author first noticed the discovery of certain forms of Amphibia belonging to the genera *Labyrinthodon*, *Brachyops*, *Petrophryne*, and *Rhinosaurus*, and called attention to certain typical peculiarities in the structure of the teeth, the form of the bony palate, and the double occipital condyle.

An imperfect cranium of the species now described as *Rhytidosteus capensis* was procured by Heer Swanepoel from the Trias on his farm of Beersheba, in the Orange Free State, and deposited by him in the Bloemfontein Museum.

This specimen, which was brought to England and submitted to the author by Dr. Exton, consists of the anterior portion of the skull with part of the mandible attached. The general form is batrachoid, and one of the hinder palato-vomerine teeth, on being examined microscopically, exhibited the characteristic labyrinthodont structure.

The surface of the skull, and the characters of the premaxillary, nasal, frontal, and prefrontal bones were described. The parietals and postfrontals are imperfect, the hinder part being lost. The rami of the mandible are also imperfect behind, but a broken fragment shows the articular surface. The vomerine bones were also described, with the posterior nostril and the teeth before and behind this opening. The breadth of the bony palate at its hinder fractured border is 5 inches; the length of the part preserved $4\frac{1}{2}$ inches; the mandible, when perfect, was probably from 11 inches to a foot in length. The author also gave an account of the dentition wielded by the premaxillary, maxillary, vomerine, palatine, and mandibular bones.

The author pointed out that the type of air-breathing vertebrates to which the present genus belongs reached its highest development in the Triassic period in Britain, Russia, North America, Hindostan, and South Africa. The only known antecedent form from which the labyrinthodont structure of tooth might have been derived is a genus of fishes named *Dendrodus*, in the Old Red Sandstone. The Liassic Ichthyosaurs also show some similarity in tooth-structure; but in them there is far greater simplicity.

2. "On the Occurrence of Antelope-remains in Newer Pliocene Beds in Britain, with the Description of a new Species, *Gazella anglica.*" By E. Tulley Newton, Esq., F.G.S.

Part of the skull and horn-core of a small cavicorn Ruminant, which had been obtained by Mr. H. B. Woodward from the Norwich Crag of Thorpe, was described, the chief points noticed being the almost erect position of the horn-core upon the frontal bone, its oval section and enlargement just above the pedicle, the presence of a deep pit on the outer side of the pedicle, and of a well-marked frontal fossa, from which a large foramen passed directly into the orbit. The frontal suture being well preserved, the precise direction of the horn-cores could be ascertained.

The presence of a frontal fossa with a foramen passing directly into the orbit, was held to indicate an affinity with the Antelopes; and after comparison with the available recent specimens in the British Museum and Royal College of Surgeons, it was regarded as most near to the Gazelles,—*Gazella dorcas*, *G. subgutturosa*, *G. picticauda*, and *G. Bennettii* being most like the fossil, and agreeing with it in having the skulls more or less compressed in the frontal region, nearly upright horns, and a well-marked frontal fossa and foramen, but differing in the form of the fossa and in the position of the pit on the pedicle. On the whole *G. Bennettii* was regarded as nearest to the fossil.

The perfect condition of the frontal bone allowed a cast of the interior to be taken, which reproduced the form of the frontal lobe of the brain, and it became possible therefore to compare this part of the fossil with the brains of recent forms, which was then done, special reference being made to the casts taken from *Gazella picticauda* and *G. Bennettii.* In the form of the convolutions of the frontal lobe, *G. Bennettii* was again found to be the most like the fossil.

Among the known fossil forms only a few were thought sufficiently near to render a comparison with them necessary; the following, however, were mentioned, and attention called to the points in which they differed from the Norwich specimen, namely *Antilope deperdita*, *A. brevicornis*, *A. porrecticornis*, *Tragoceros Valenciennesi*, and *Palæoryx parvidens.* Seeing that all the important characters of this fossil are found among the recent Gazelles, it is referred to that genus; but as it differs in certain points from each of them, it is necessary to give it a new specific name; the author therefore called it *Gazella anglica.*

Fortunately this interesting discovery is corroborated by two other similar examples of horn-cores with frontals from the same locality and horizon. One of them is in the British Museum, and the other in the possession of Dr. Arthur King, of Norwich.

A short appendix, by Mr. H. B. Woodward, on the horizon from which these fossil Gazelles were obtained was also read.

3. "A Comparative and Critical Revision of the Madreporaria of the White Lias of the Middle and Western Counties of England, and of those of the Conglomerate at the Base of the South-Wales Lias." By Robert F. Tomes, Esq., F.G.S.

After referring to previous memoirs on the subject by MM. Tawney, C. Moore, Tate, and Bristow, and to the conflicting conclusions arrived at by those geologists, the author insisted that the Madreporaria are not necessarily contemporaneous with the beds in which they are found imbedded. He took exception to some of the identifications of these forms by Dr. Duncan, and suggested that their nearest analogues are to be found in the St. Cassian beds.

The few and imperfect corals of the White Lias of Warwickshire, the author believes to have resemblances with the coral fauna of the Sutton Stone on the one hand, and the St. Cassian beds on the other. The Mollusca found in the same beds, however, are those of the zone of *Ammonites angulatus*.

While the Brocastle Conglomerate is, according to the author, a local deposit with uncertain relations, the Sutton Stone is a much more regular stratum, and is quite distinct from the conglomerate which immediately overlies it, and which is seen at Southerndown. He regarded the Sutton Stone as the equivalent of the White Lias, and of Rhætic, not Liassic age.

The revised list of corals found in the St. Cassian beds, the White Lias, the Sutton Stone, and the Brocastle Conglomerate respectively, shows, according to the author, that nearly all the White-Lias forms occur at St. Cassian; that a certain number of the corals of those two formations occur also in the Sutton Stone, but that none of them occur at Brocastle; and, furthermore, that the coral faunas of Sutton are quite distinct.

In conclusion, the author contested the views of the late Mr. C. Moore concerning the existence of a series of conglomerates below the base of the Sutton Stone, and insisted that the presence of a Hettangian molluscan fauna in these beds and the White Lias is not sufficient to counterbalance the evidence of Rhætic affinities afforded by the corals. The Brocastle Conglomerate, however, contains corals with Liassic affinities.

Detailed descriptions of the new species of corals formed the conclusion of the paper.

April 2, 1884.—Prof. T. G. Bonney, D.Sc., F.R.S., President, in the Chair.

The following communication was read:—

"On a new specimen of *Megalichthys* from the Yorkshire Coalfield." By Prof. L. C. Miall, F.G.S.

A large and unusually complete example of this fish was recently found in the roof of the Halifax Hard bed, at Mr. S. B. Ellison's Firebrick works, Idle, near Leeds. The fossil is in good preservation, the ventral surface is uppermost, the pectoral, ventral, anal, caudal fins can be more or less satisfactorily made out; the dorsal surface is absent. The length is 3 feet $8\frac{1}{2}$ inches, of which the head measures about 10 inches, and the tail (from the end of which 5 or 6 inches may be wanting) about a foot. Judging by the large skull figured by Agassiz and preserved in the Leeds Museum, *Megalichthys* may have attained a length of from 4 to 5 feet.

The skull shows the mandible and mandibular teeth, the end of the snout, the opercula, and the jugular plates. The pectoral fins show the obtuse lobate character, previously suspected by Huxley to obtain in this genus. Large basal scales lie on each side of each pectoral fin.

The ventral fins are abdominal. The right, which is best preserved, exhibits the arrangement of the scales which is described, and which gives a clue to the disposition of the underlying bones or cartilages. This must have closely resembled that in some Elasmobranchs. The same type of fin may be traced, though with important modifications, in *Polypterus*, *Polyodon*, and *Acipenser*, whilst in other recent Ganoids and in Teleostei the arrangement is widely different.

Between the ventral fins are three large scales, one median and two lateral. On the left side of the median scale lies what appears to be the anus. A similar arrangement seems to occur in *Pterichthys*. This region is rarely exposed in fossils.

The anal fin has also its pair of large basal scales. The caudal fin cannot be well made out. There are indications of the underlying skeleton, but nothing can be distinctly made out.

All the features of the present fossil confirm the opinion long ago expressed by Pander and Huxley as to the near affinity of *Megalichthys* to *Osteolepis* and *Diplopterus*.

BIBLIOGRAPHICAL NOTICE.

Geological and Natural-History Survey of Canada: Catalogue of Canadian Plants.—Part I. *Polypetalæ.* By John Macoun, M.A., F.L.S., F.R.S.C. Montreal, 1883.

Most of our colonial governments have recognized in an enlightened manner the great importance, even from a merely commercial stand-point, of a complete stock-taking of their natural productions. Mineral wealth has no doubt generally been looked to first; and the necessity for the conservation of forests and of animals yielding food and clothing has not always been recognized so readily as the immediate profit to be obtained from them; but the value of the knowledge of what plants and animals the country contains has led to the frequent conjunction of Natural History departments with State Geological Surveys. This healthy sign of wise counsels is seen in the work before us—the first part of a catalogue of Canadian plants, issued by the "Geological and Natural-History Survey" of the Dominion; and the colony is to be congratulated on the business-like manner in which Mr. John Macoun has begun his task. The form, paper, and printing of the work are admirable, the type being especially clear; and beyond the dropping of a letter here and there, as in the generic initial of the fourth species mentioned, the appearance of *Alianthus* for *Ailanthus*, and one or two slips of the kind, no fault can be found under this head. In a short preface the Author summarizes the brief literature of his subject and the history of botanical exploration in the country, enumerating also the collections examined for the purposes of the work. From this it appears that the Survey-staff have been collecting for the last ten years, but that the examination of the Rocky-Mountain region and of British Columbia is still very imperfect. When we remember that the area of the Dominion is estimated at over three and a half million square miles, or little less than that of Europe, we cannot expect it to be as yet at all completely known to the botanist, as is perhaps evident from Mr. Macoun's Catalogue, which enumerates 907 species of Polypetalæ under 243 genera, as against 616 species in the 193 genera of the same group in our British flora, according to the 'London Catalogue.' One useful detail in Mr. Macoun's work is that both the genera and the species are numbered continuously throughout, thus facilitating the above comparison, which gives the possibly significant result of an average of 3·73 species to every genus in the continental, as against 3·18 in the insular flora. It must, however, be noticed that Mr. Macoun has included in his numbering not only "introduced plants," "garden escapes," and those "spontaneous in gardens," but also planted trees, such as the horse-chestnut and *Tilia europœa*, and even species "likely to be found"! There are at least a hundred of these in the present part, and their inclusion without typographical distinction seems perfectly unjustifiable, though the indication of the western migration of such plants as *Papaver somniferum* and *P. Rhœas*, *Chelidonium*, *Armoracia*, *Capsella*, *Thlaspi arvense*, and the *Brassicas* is undoubtedly of interest.

It is remarkable that the list includes so many migrants from the east and but very few from the south. There are, of course, many names and authorities for names that might be called in question according to the law of priority; but this is no new fault in recent systematic works; blemishes perhaps of a more practical bearing and more readily remediable, however, are, first, that no apparent distinction is made between *bonâ fide* local names, as May-flower, Yellow Puccoon, and White Cohosh, and mere "book-" names, such as Virgin's-Bower, Awl-wort, or Thyme-leaved Pin-weed; and, secondly, that the localities are stated continuously, with no obvious grouping under provinces or natural divisions. In a catalogue it may have been inevitable to insert under the genus *Astragalus* two unnamed species without descriptions, which can only be referred to by their numbers or localities; but it is a course open to considerable objection. When all is said, however, these are but slight faults in a generally excellent piece of work, and the continuation of Mr. Macoun's list will be looked forward to with interest. The apparent occurrence of natural hybrids of *Nuphar* (a characteristic, as appears from Mr. Thomas Meehan's publications, of the allied genus *Sarracenia*) is one among many points of interest in the work, and the flora with which it deals is characterized by possessing 37 species of *Astragalus*, 29 of *Potentilla*, 27 of *Ranunculus*, 26 of *Saxifraga*, 22 of *Viola*, 17 of *Ribes*, 16 of *Arenaria*, 14 of *Lupinus* and of *Anemone*, 13 of *Stellaria*, 12 of *Cornus*, 10 each of *Geum*, *Œnothera*, *Desmodium*, and *Claytonia*, 8 of *Acer*, 7 of *Rhus*, and 5 of *Parnassia*. Such a catalogue makes a botanist hope that it may be speedily followed by such a descriptive flora as shall be a credit to the largest of our colonies.

G. S. Boulger.

MISCELLANEOUS.

Freshwater Sponges as Improbable Causes of the Pollution of River-water.

Mr. Potts reported that on the 9th of February he had visited and partially examined the forebay at Fairmount Waterworks, on the Schuylkill River, from which the water had been temporarily withdrawn, with a view to discover the winter condition of the freshwater sponges and the other inhabitants of that locality. He found by far the larger part of the wall-surface below the water-line inaccessible on account of a thick deposit of mud upon the bottom and much water remaining in the forebay. Wherever reached, however, and so far as the eye could detect in other places, it was covered by a mud-coloured incrustation of considerable thickness, which a more minute examination showed to be composed almost wholly of the statoblasts and spicules of the sponge *Meyenia Leidyi*. Some few fragments of *Meyenia fluviatilis* and *Spongilla fragilis* were seen, but the first-named was clearly the prevailing species.

A sluiceway which formerly supplied the last of the old "breast wheels" used in pumping into the reservoir, but from which the water had been for many months excluded, was entered and examined. Here the remaining incrustation (much having doubtless crumbled and fallen away) was from one fourth to one half an inch thick, of the appearance of crumbling plaster, and, as in the other cases, it consisted of the sponge before named, with but a small proportion of intruded material.

While considering the effect of the presence of so large a sponge-growth at the very inlet to the supply-pumps, Mr. Potts stated that this particular species was conspicuous among the known North-American sponges by its great relative density and the small proportion of its sarcode or flesh. Its decay, therefore, at the termination of its period of summer growth would be a less cause of pollution to the water-supply than that of any other sponge.

Moreover, from recent investigations into the life-history of these low organisms, he was inclined to believe that decay was not the normal or necessary result of the close of each season's growth. The fragile branches of some species inhabiting exposed situations may, of course, be broken off and destroyed while the sarcode still covers them ; but in the sessile portions, and in all when sufficiently protected, the cells of the sarcode at the period of full maturity, forsaking their places along the lines of the skeleton framework, gather together by simultaneous amœboid movements into dense groups, where they are soon covered by a tough chitinous "coat," which, in time, generally becomes surrounded by a "crust" of minute granular cells, and armour-plated by a series of protective spicules. These groups are now recognized as the statoblasts, gemmules, or winter-eggs of the sponge—eggs only in appearance—in reality the resting-spores or protected germs which conserve the life of the individual through the cold and storms of winter, and awake very early in the springtime into new life—yet a continuance only of the same existence which was seen a few months before nestling into this winter's sleep.

If this is the ordinary course with these organisms there seems no reason to regard them as serious causes of the pollution of our streams, though violent freshets before this resting-period is reached may tear them to pieces, and their decay may give a temporary taint to the water.

Continuing the narrative of his exploration, Mr. Potts described the iron pipes which had lain for many years upon the bottom of the forebay, as covered, in some places to the depth of an inch or more, with a crust richly coloured by iron oxide, but principally composed, as were the others, of the spicules and statoblasts of *M. Leidyi.* Upon the surface of this crust in places he found the remains of large colonies of *Urnatella gracilis*, Leidy. In the absence of any positive knowledge of the winter condition of this curious polyzoan, Mr. Potts had examined with much interest a novel form of statoblast, which was frequent upon the same pieces of sponge ; but he was unsuccessful in associating it with the polyzoan. It is most probable that the life is continued, as suggested by Dr. Leidy, within the urn-like joints of this creature, and that they put out buds and a new growth in the spring. To discover if this were the case, he had placed some fragments in water, and while awaiting results he had been surprised at the appearance within a few days amongst the fragments of *Urnatella* of numbers of the recently described chæto-branch worm, *Manayunkia speciosa* of Leidy, as well as several living cells of a species of *Paludicella*, probably *P. elongata*, of the same author. The persistence and tenacity of life in these apparently delicate creatures, overcoming not only the severity of a hard winter, but an exposure of several days in the open air, were further commented upon.—*Proc. Acad. Nat. Sci. Philad.*, Feb. 12, 1884, p. 28.

On the Brain of Eunice Harassii *and its Relations with the Hypodermis.* By M. E. Jourdan.

Quatrefages and Claparède were the first to indicate the relations that exist between the hypodermic cellular layer and the nervous centres in some Annelides. More recently Ehlers, with reference to the brain of the species which is the subject of the present note, and Spengel, in his memoir upon a Eunician, *Oligognathus Bonelliæ*, have pointed out the difficulty of separating the brain from the hypodermis in the cephalic lobe of these worms. These notions, so contrary to the classical data and figures relating to the brain of most Annelides, seemed to us to need confirmation. With this view we have made sections of the whole of the cephalic lobe, including both the brain and the integuments of the species under consideration. The observations that we have been able to make by this method have not only allowed us to demonstrate the correctness of the opinion of Ehlers and Spengel, but have also revealed some new facts.

The brain of *Eunice Harassii*, upon the external form of which we shall say nothing, seeing that this apparatus is very imperfectly limited, consists essentially of a central mass of punctate substance, surmounted by a thick layer of nervous cells, designated by Ehlers the *nuclear layer*.

Above this nuclear zone, and immediately beneath the cuticle, we see epithelial elements in the form of cones, with their apices directed towards the deeper surface of the integuments. The feet of these hypodermic cells, instead of terminating upon a basal, as in the case of the integuments of the rest of the body, become transformed and prolonged into so many rigid threads, which penetrate into the nuclear layer, grouping themselves together in larger or smaller numbers, to form a sort of pillar passing from the cuticle to the mass of punctate substance. The protoplasm of these hypodermic cells is much reduced in quantity; their nuclei have a characteristic fusiform aspect. The basal prolongations appear as rigid threads with a vitreous aspect and with a clean fracture. United into bundles, these hypodermic fibres are not stained readily by carmine or by hæmatoxyline; but under the influence of hæmatoxylic eosine they acquire the pearl-grey coloration characteristic of the cuticle and basals of the hypodermis of Annelides. It is impossible to trace one of these filaments from the hypodermic cell to which it belongs to the punctate substance; they lose themselves in the nuclear layer, where they become intimately confounded with other fibrillæ presenting similar histological characters, but having a different origin.

The nuclear layer is justly regarded by Ehlers and Spengel as of nervous nature, but it is composed of elements of varied aspect. In a section this layer appears as a delicate network filling up the space between the pillars of which we have just spoken, and the meshes of which are occupied each by a spherical nucleus. It is very difficult, in the sections, to know whether this network is constituted by sections of cell-membranes soldered together by means of a cement or by very delicate fibres. Dissociations enable us easily to answer this question; they show that the nuclear layer consists of nerve-cells each possessing a large nucleus, a protoplasm so reduced that they seem to be destitute of it, and a fine enveloping membrane. We notice also that from each of these cells there start most frequently one, but sometimes two processes. These filaments are very delicate, and, when examined with an objective giving an enlargement of 400 or 500 diameters, comparable to the appearance presented by a spider's thread seen with the naked eye. By several of them becoming grouped and soldered together, these filaments constitute the cross-lines of the meshes of the network which are observed in the sections. Among these cells reduced to their nucleus, which form nearly the whole of the nuclear layer, we observe a certain number distinguished by their larger dimensions; they possess a nucleus and a finely granular protoplasm, which is coloured yellow by picrocarmine; from their peduncle starts a process which mingles with those of the small nerve-cells, and likewise penetrates into the punctate substance.

By examining the boundaries of the nuclear layer and punctate substance we easily distinguish a great number of fibrillæ which emanate from the nerve-cells and become connected with the punctate substance. It is impossible to say what the fibrillæ of the hypodermic cells become at this level, or to know whether they penetrate into the punctate substance or lose themselves at its surface. These fibres, of which the origin and no doubt the functions are so different, in fact present such similar histological characters in *Eunice Harassii* that it is impossible to distinguish them. The punctate substance itself consists essentially of a mass of interlaced fibrillæ forming a network which is more or less close in different regions. The spaces left vacant by the meshes of this fibrillar network are filled up by a finely granular protoplasm, which acquires a lilac-rose colour with hæmatoxylic eosine, and is perhaps comparable with the granular substance of the neuroglia of Vertebrates.

The principal facts resulting from the preceding observations, and which seem to us to be of some interest in general anatomy, are as follows:—In the first place, the intimate mixture of the hypodermic epithelial cells and of their basilar processes with the cells of the nerve-fibres, from which results the difficulty of defining the brain in a clear and certain manner; and the absence of any histological character enabling us to distinguish the basilar fibrillæ of the hypodermic cells from the nervous fibres. It seems to us to be interesting to point out these anatomical peculiarities, which remind us of the condition of the nervous system in the larvæ of Annelides*.—*Comptes Rendus*, May 19, 1884, p. 1292.

* Kleinenberg, "Origine du système nerveux central des Annelides," in Archives Italiennes de Biologie, tome i. p. 67.

On Manayunkia.

Prof. Leidy made some remarks on a specimen of *Manayunkia*, of which he exhibited a drawing, and which had been recently obtained by Mr. Edward Potts, from the mill-pond of Absecom Creek, at Absecom, N. J. It was of especial interest as apparently confirming the freshwater habit of a cephalobranch annelide. The worm was contained in a tube attached to the midrib of a decayed leaf, to which there were attached several similar but empty tubes about 1 line long. The worm, 1·5 millim. long, appears to be an immature form of *Manayunkia speciosa*. The body consists of ten setigerous segments succeeding the head. The latter supports two lophophores, each with ten tentacles, of which none are conspicuously larger than the others. A pair of eyes occupy the head, but no pigment spots exist along the base of the tentacles. The podal setæ are from two to four, but mostly three, on each side of the segments. The podal hooks, but one on each side of the setigerous segments, except the first of the latter, which has none; and the last two, which have rows of six comb-like hooks on each side. The worm is translucent white, and the blood very pale green.

Ordinarily, Absecom pond is purely fresh water, and contains in abundance the usual plants and animals characteristic of fresh waters. Mr. Stuart Wood stated that in occasional extreme high tides of Absecom Creek, the pond had been subjected to the overflow of salt water.—*Proc. Acad. Nat. Sci. Philad.*, Dec. 1883, p. 302.

On a Mediterranean Species of Lingulinopsis. By Dr. L. G. Bornemann, Jun.

In 1860 Reuss established the genus *Lingulinopsis* for a Foraminiferan intermediate between the families Rhabdoideæ, Glandulinidæ, and Cristellaroideæ. He referred to this genus the form previously described by him under the name of *Lingulina bohemica* from the Pläner near Teplitz. Subsequently Schwager united with it *Amphistegina striata*, Reuss, from the Neocomian of Westphalia. The author now records the occurrence off Carloforte (in the island of San Pietro, Sardinia) of a recent species of the genus, for which he proposes the name of *Lingulinopsis carlofortensis*. It is a rather large species, over 5 millim. long, and lives in great abundance on the beds of coral in the above locality.—*Atti della Soc. Toscana di Sci. Nat., Mem.* vol. vi. p. 26.

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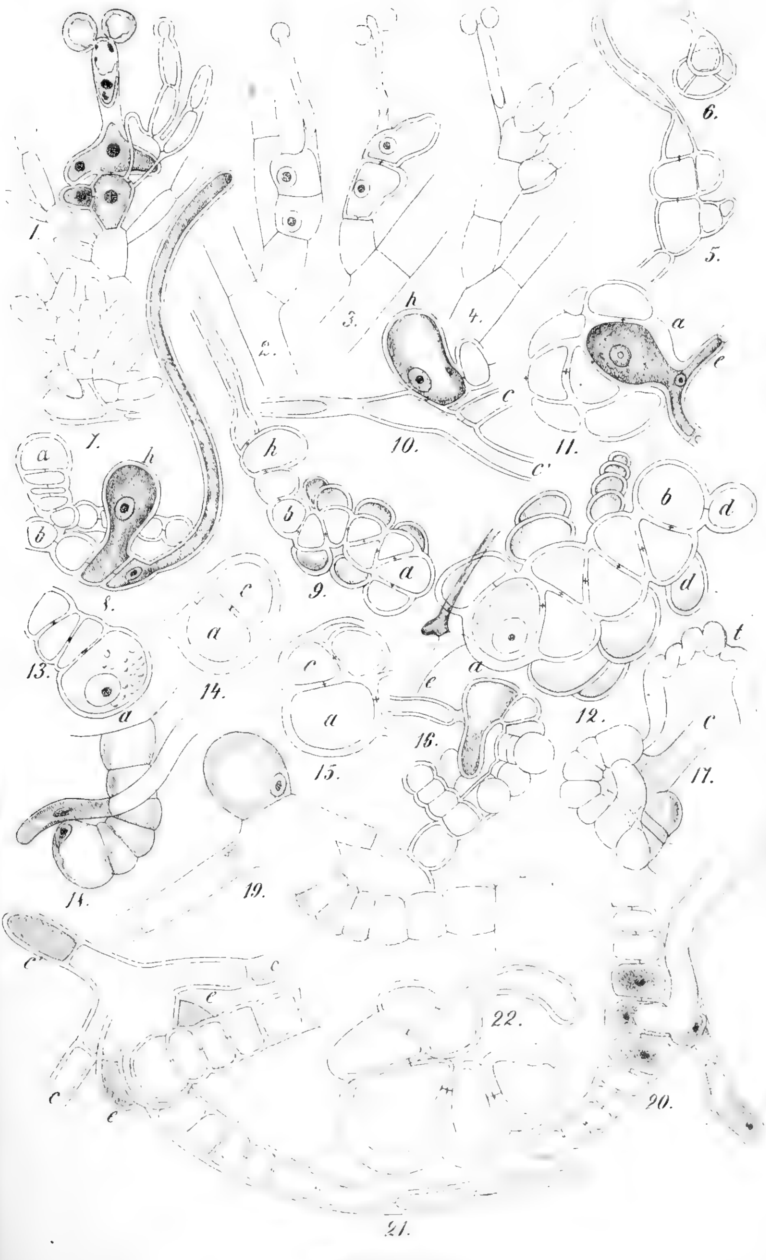
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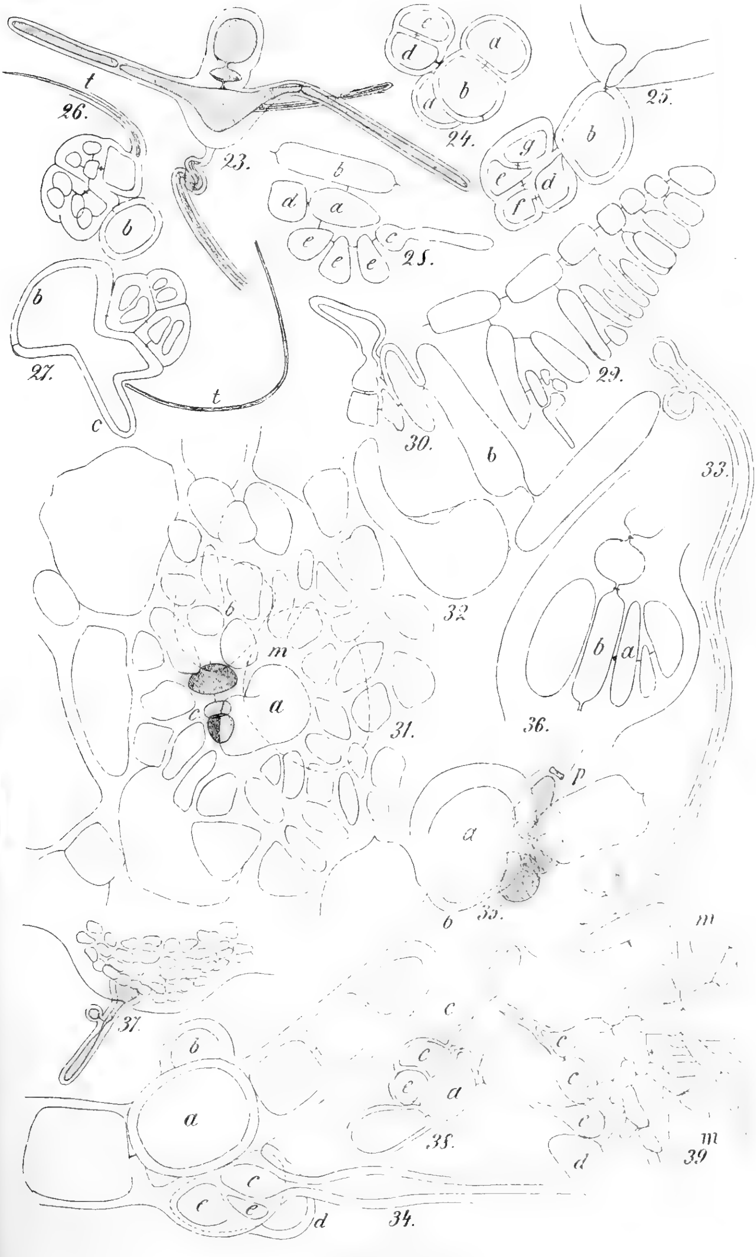
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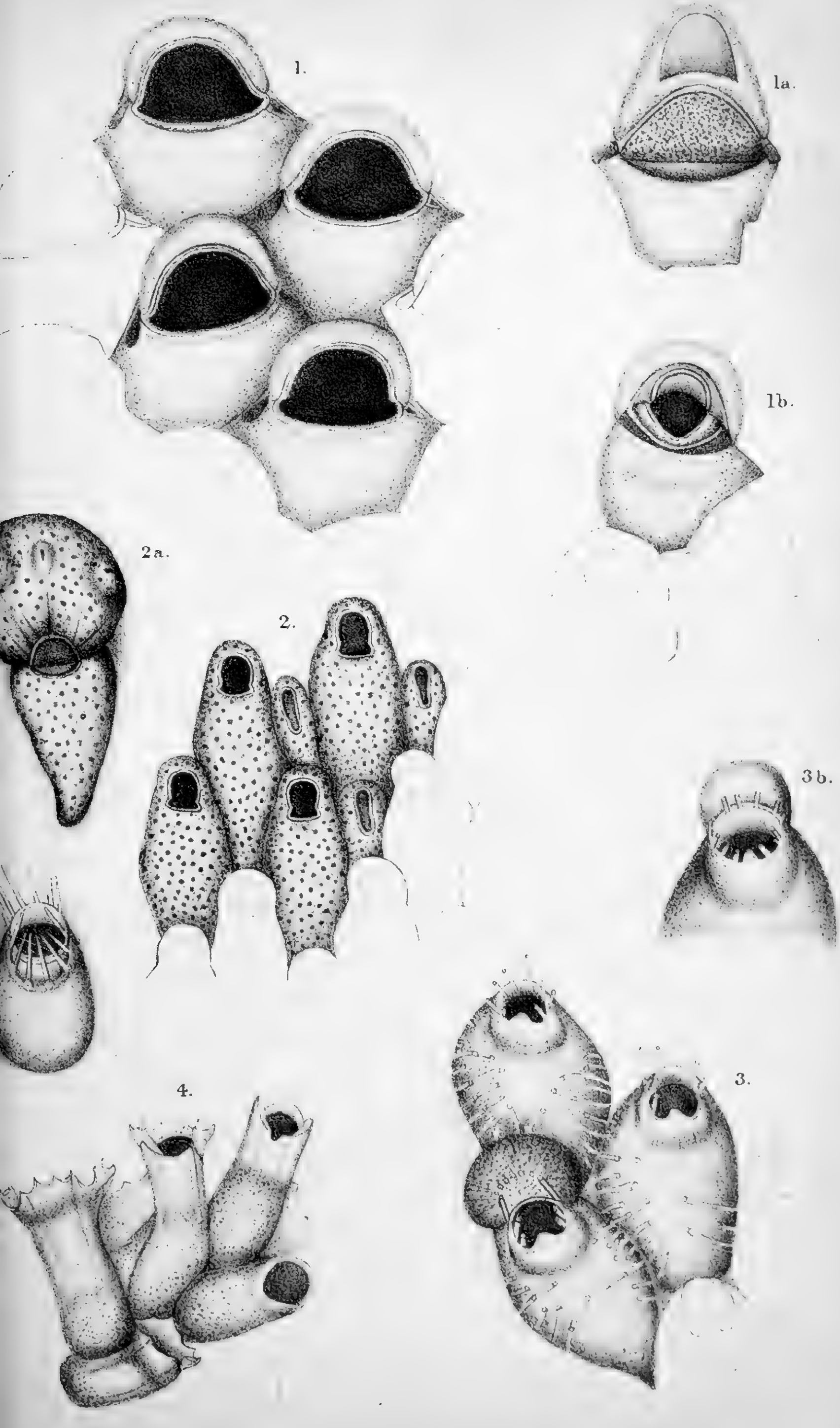

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Robt Kidston del.

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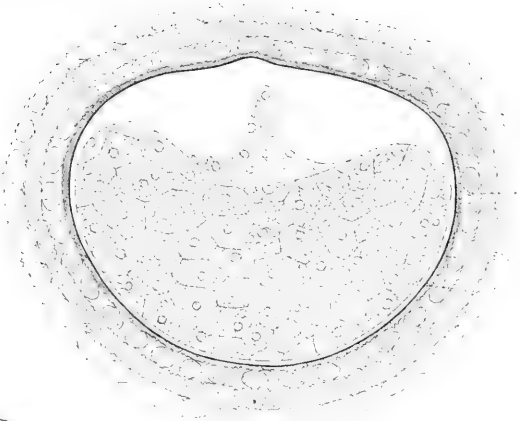
1. SPIROPTERIS. (PECOPTERIS POLYMORPHA. *Bgt.*) 2. SCHUTZIA BENNIEANA. *Kidst.*



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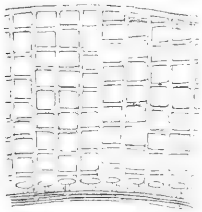

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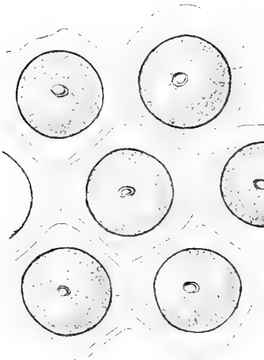

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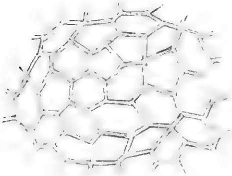

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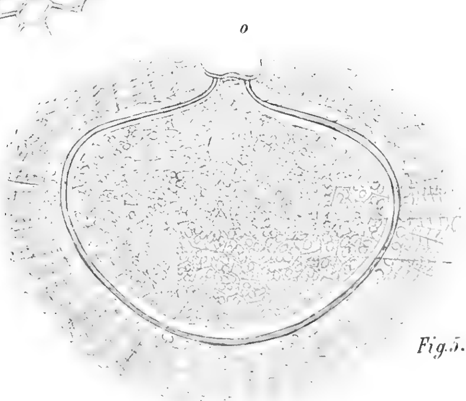

Fig. 5.

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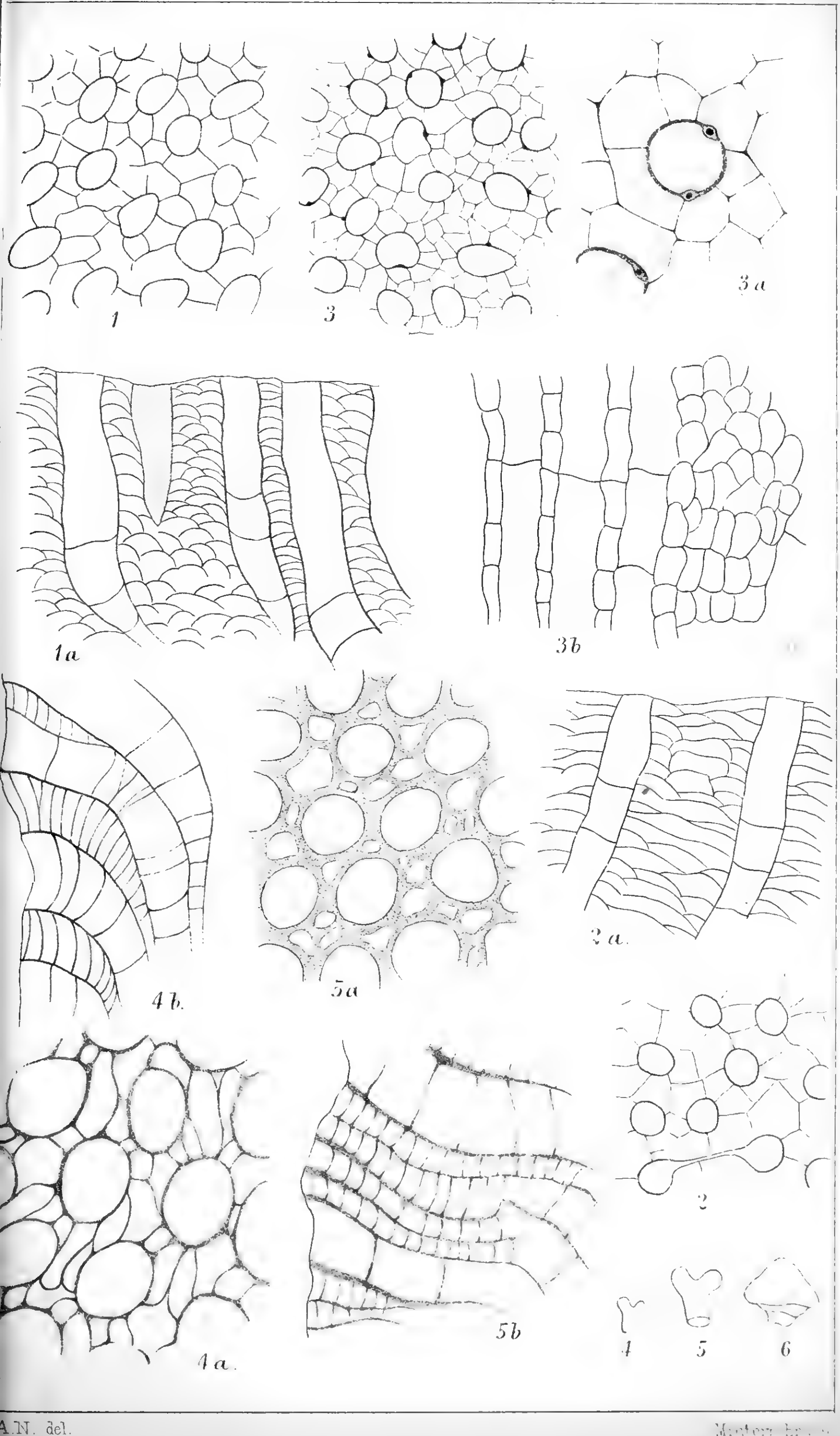
Fig. 1-2 Ephydatia amphizona.—— Fig. 3-6. Trochospongilla erinaceus.



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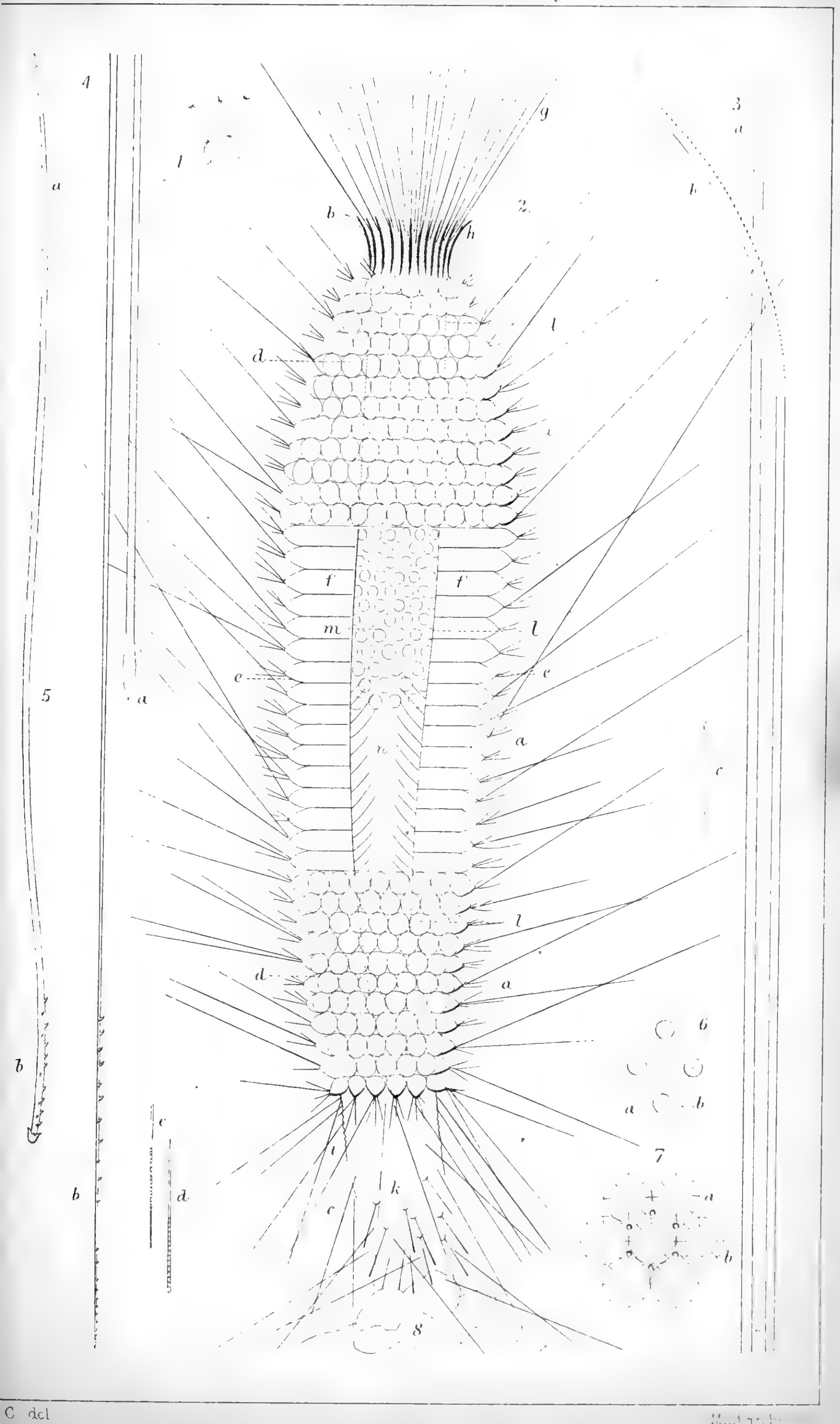
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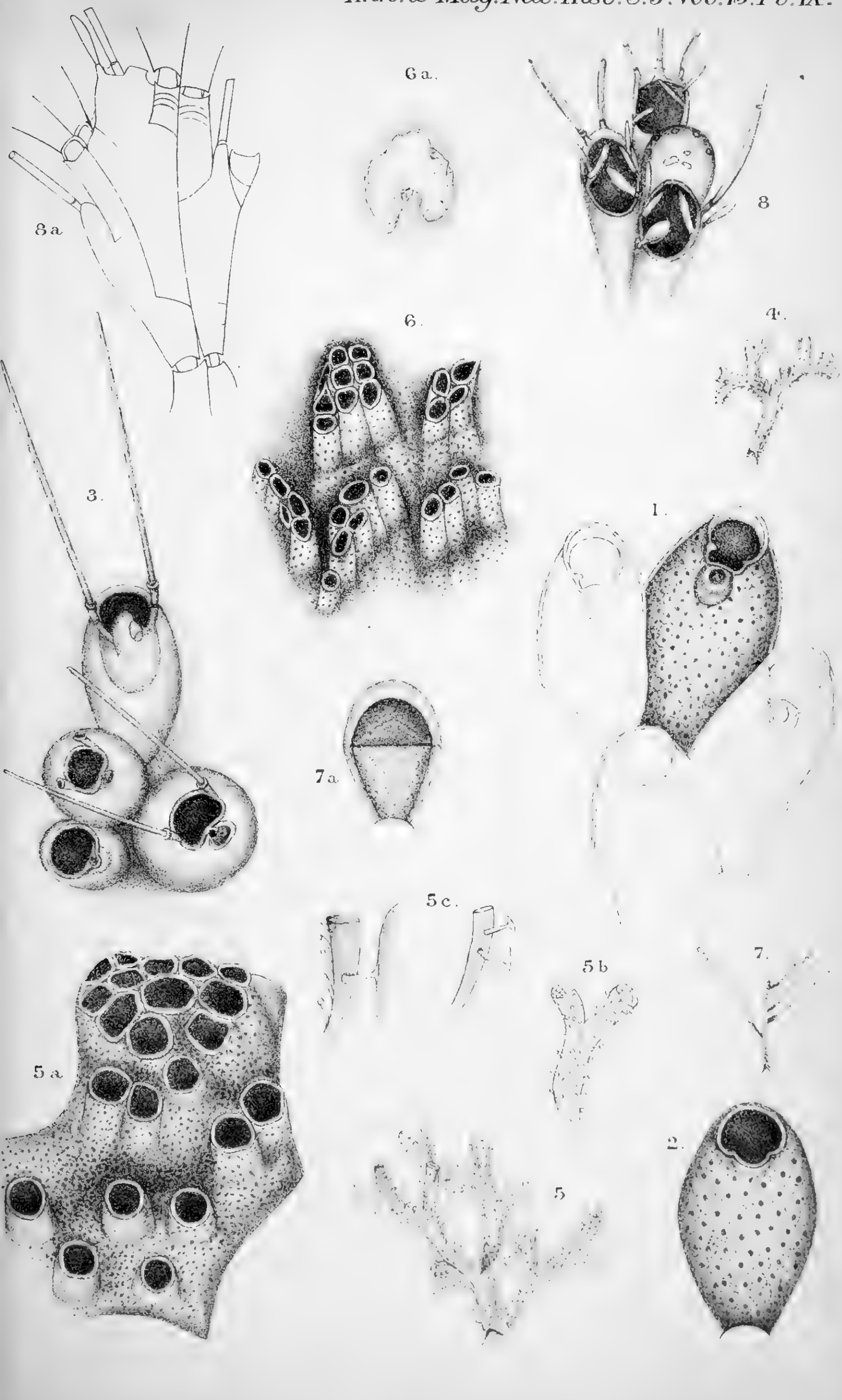

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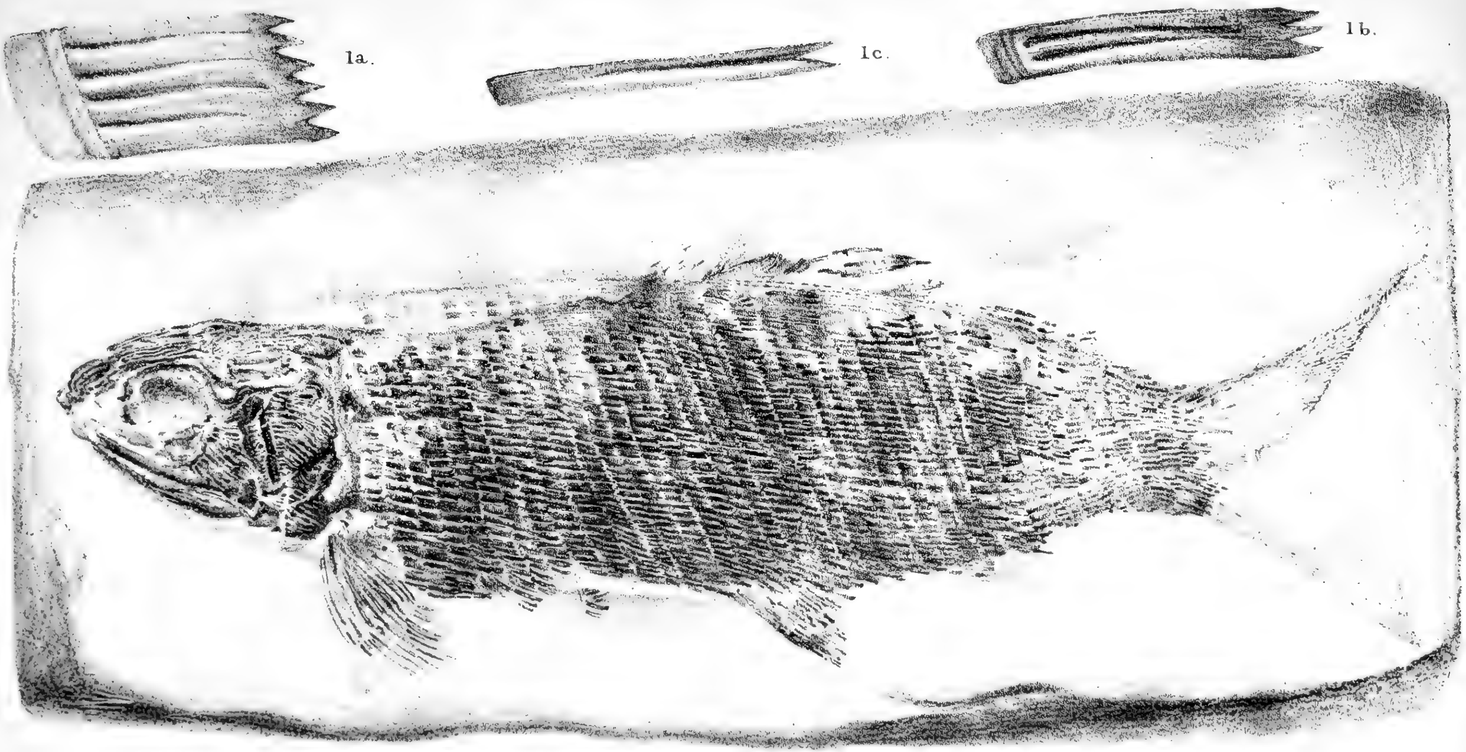

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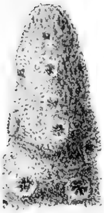

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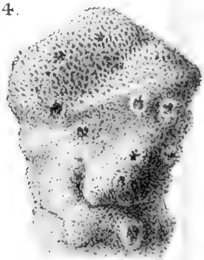

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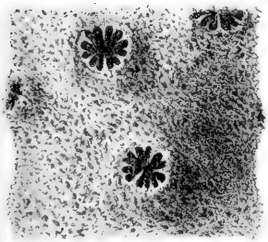

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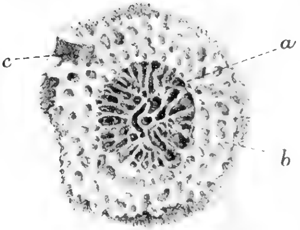

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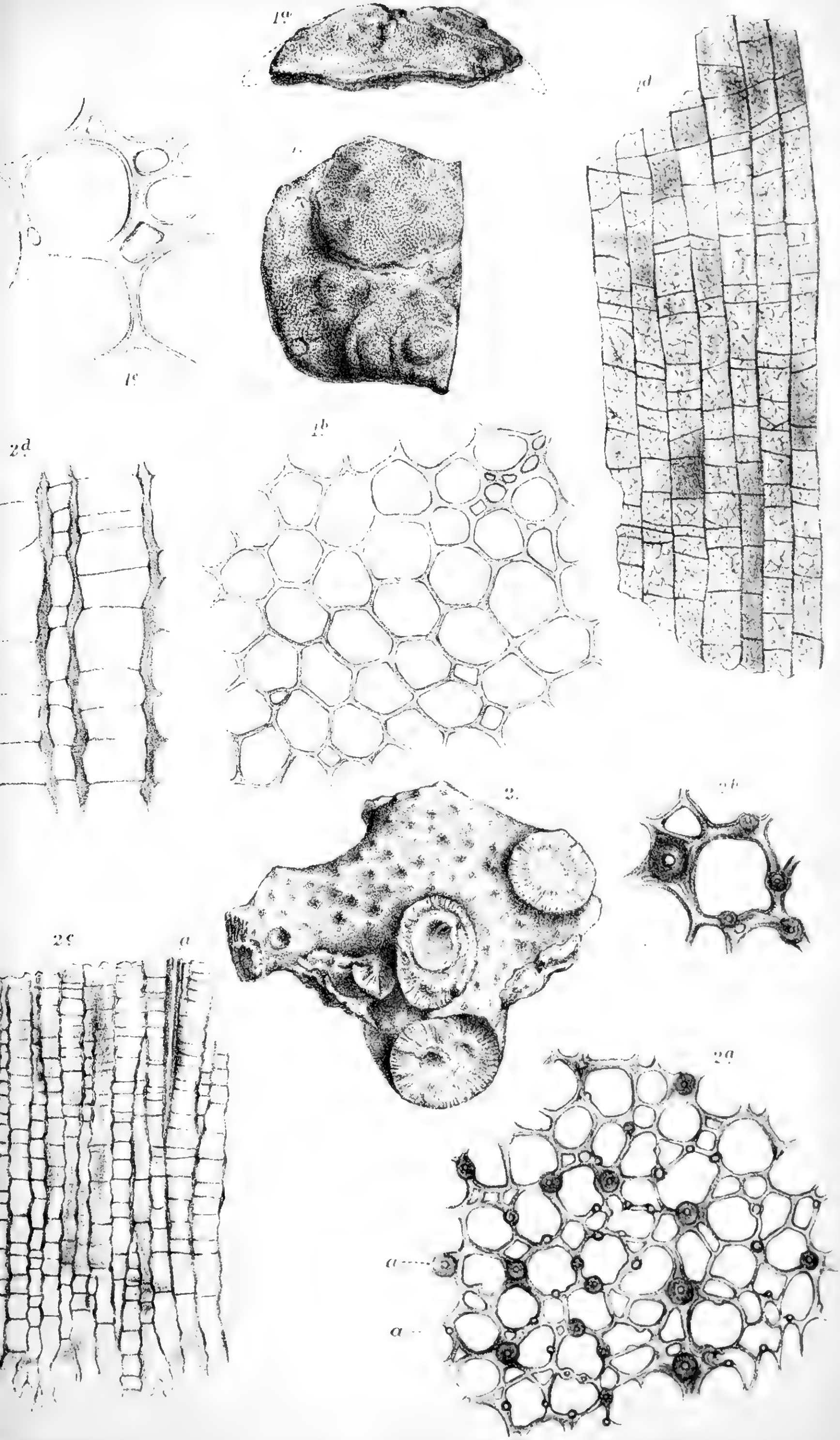

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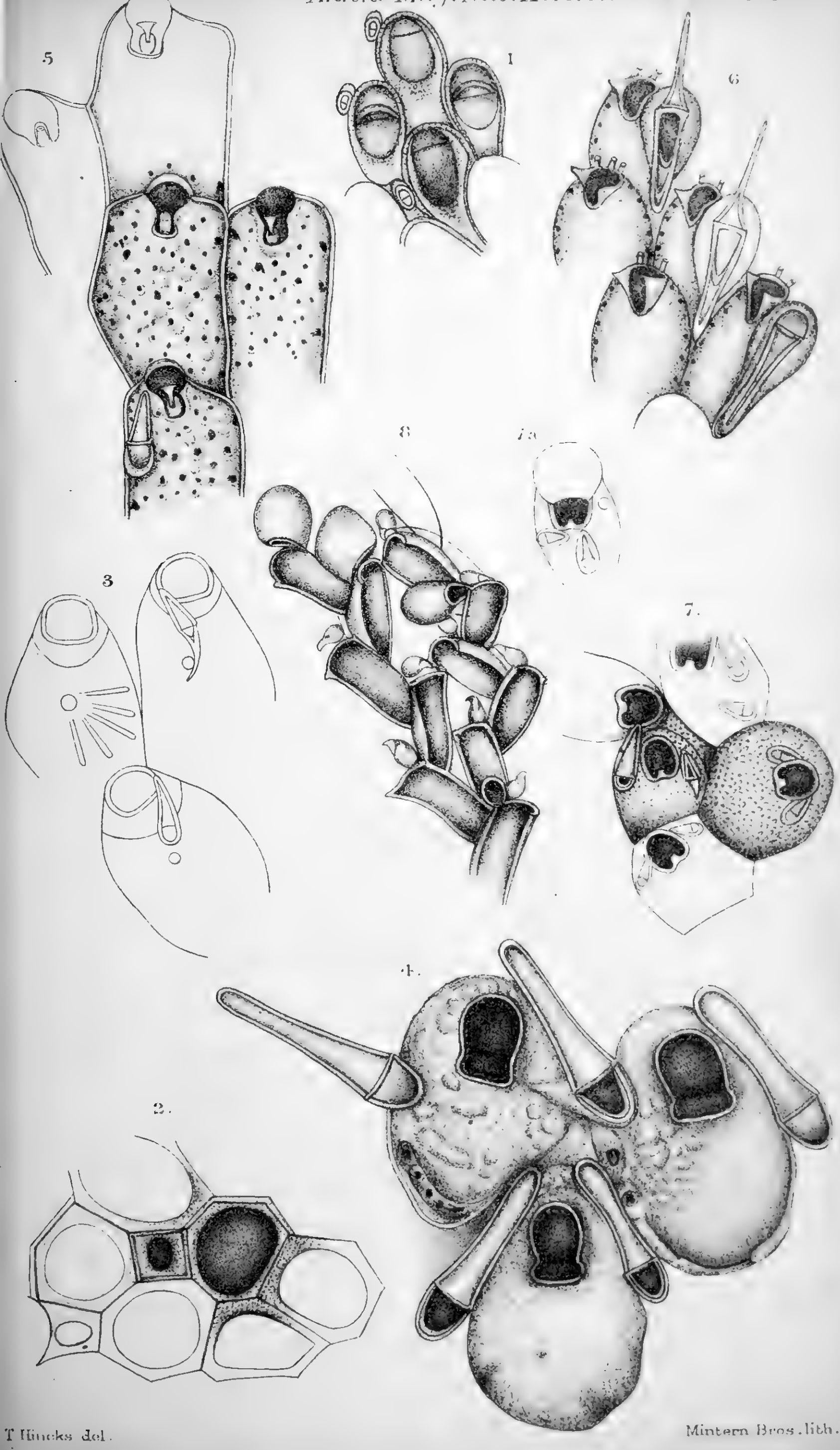

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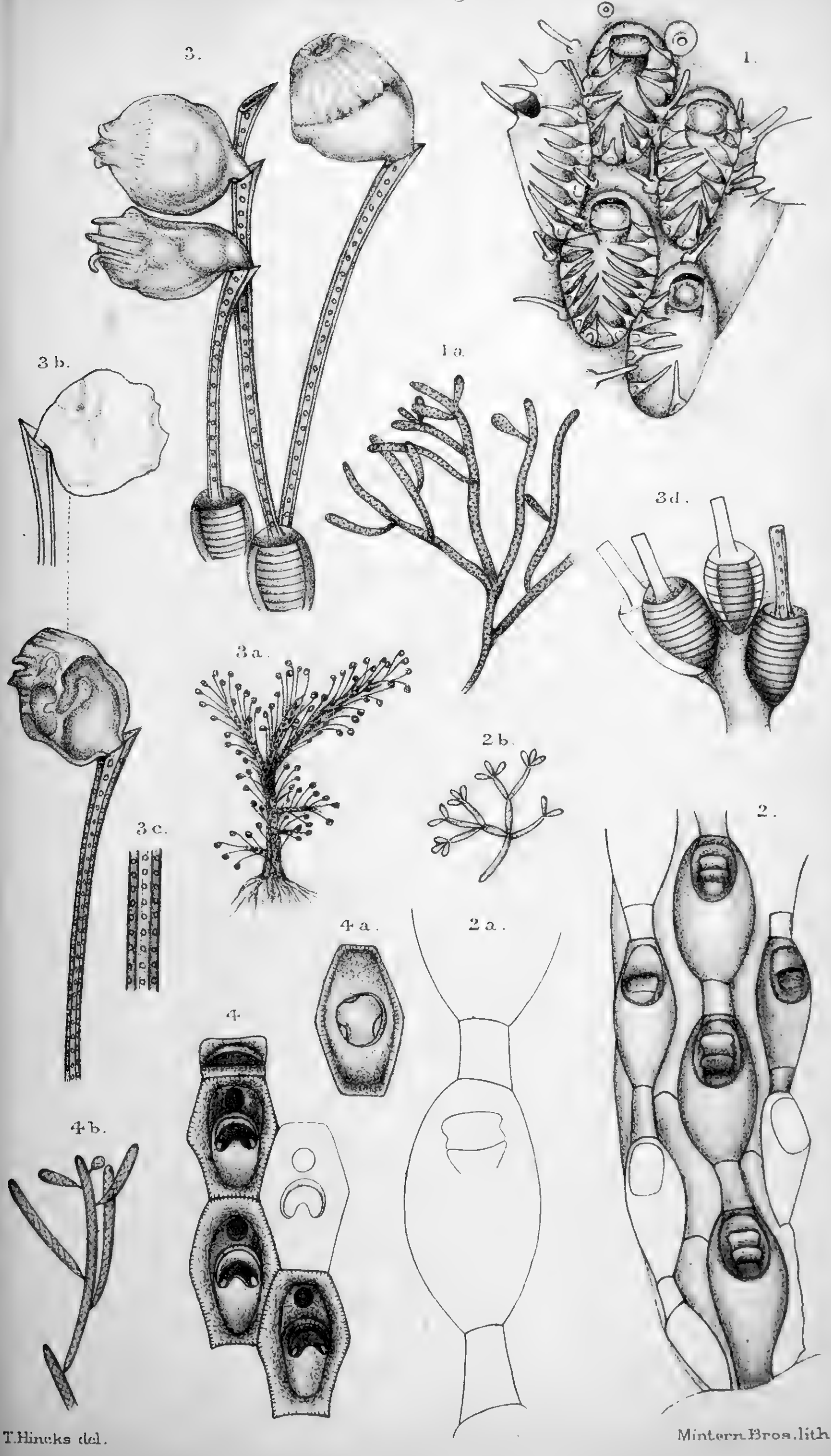

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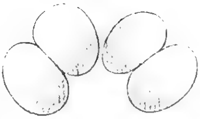

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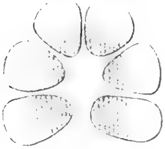

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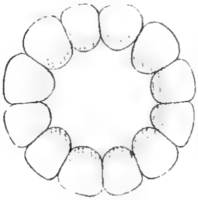

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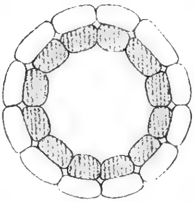

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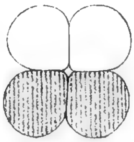

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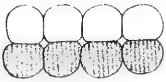

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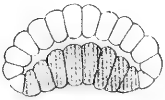

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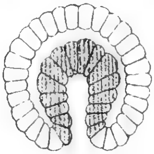

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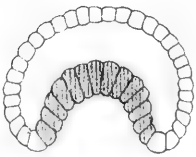

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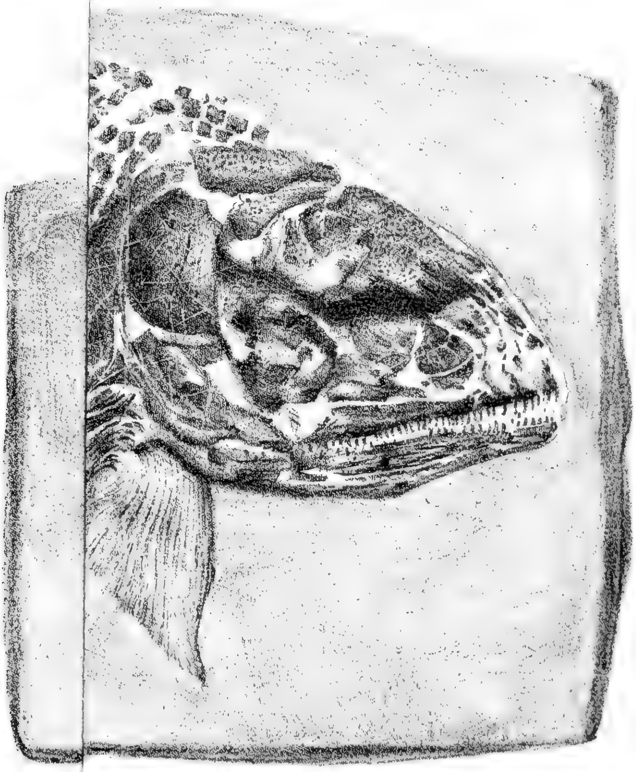

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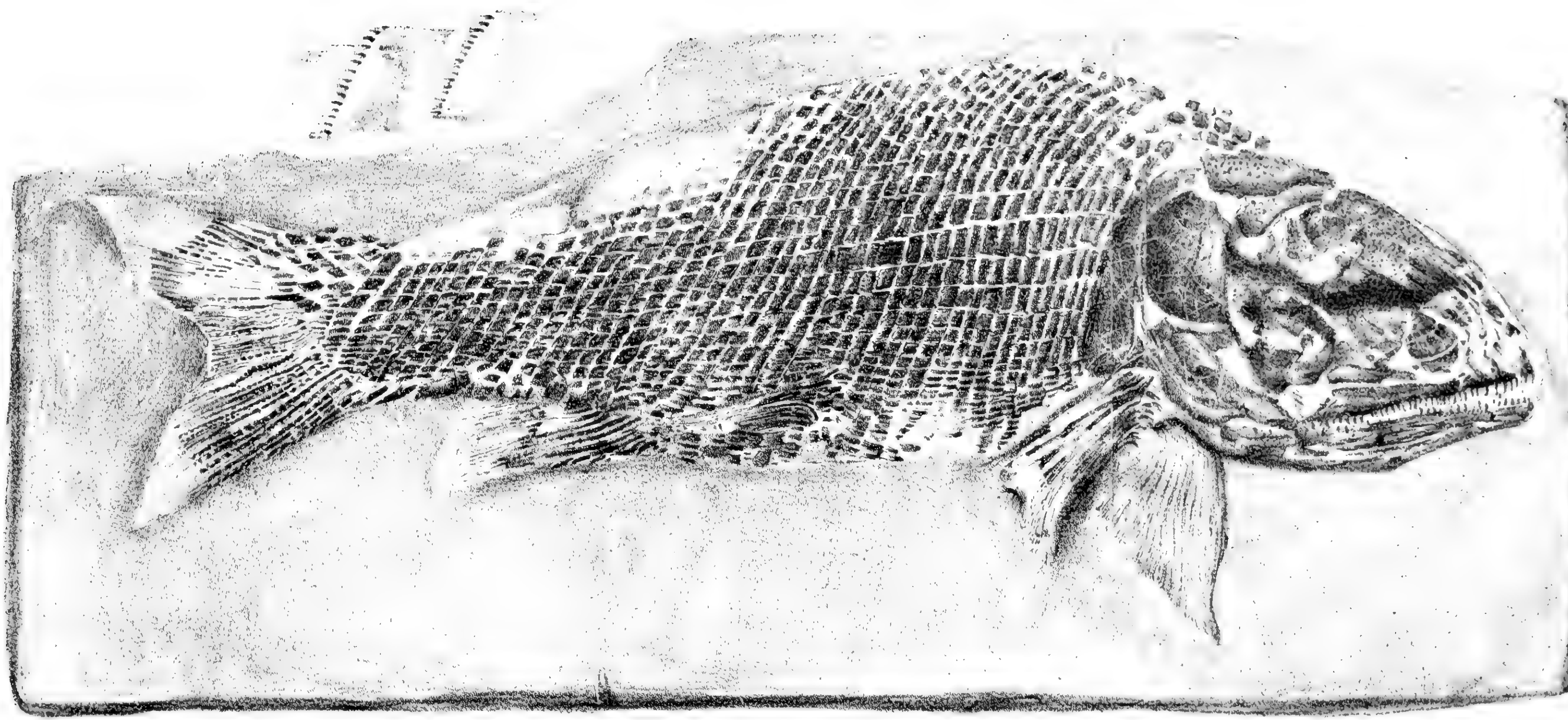
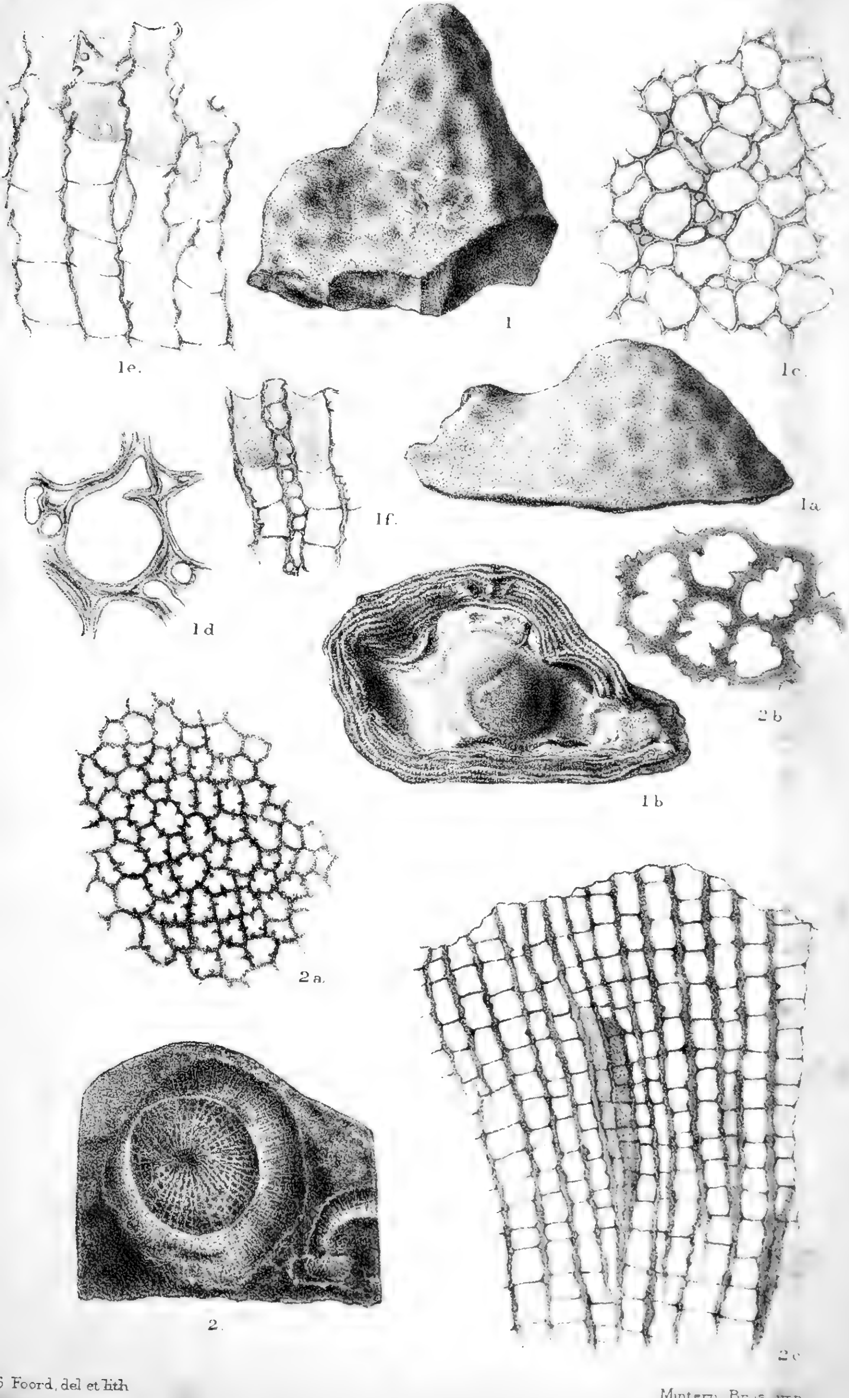


H. Sykes del. LISSOLEPIS SERRATUS. *Davis.* Mintern Bros. imp.



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