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

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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.

[FOURTH 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. 25. JANUARY 1870.

I.—*On the Organization of Sponges, and their Relationship to the Corals.* By Ernst Häckel*.

The class of Sponges has hitherto stood, in many respects, isolated in the world of organisms. No other class of the animal or vegetable kingdom, containing an equal number of abundant, large, and multifarious forms, has left naturalists, even up to the most recent times, so much in doubt as to its true nature, or called forth such a number of contradictory opinions. Whilst most of the older naturalists regarded the Sponges as plants, and most of the modern ones considered them to be animals, the intermediate opinion also made itself felt from time to time—namely, that from the indifferency of the characters of their organization, and from their mixture of animal and vegetable peculiarities, they were to be assigned to that remarkable group of the lowest and simplest organisms, which (in my 'General Morphology of Organisms') I have placed as the kingdom of the Protista, between the animal and vegetable kingdoms. Without entering here upon an historical exposition of the numerous different opinions which have ever been entertained by naturalists as to the position of the Sponges in the classification of organisms, the opposite stand-points of the most esteemed naturalists may nevertheless be briefly indicated.

* From the 'Jenaische Zeitschrift,' Band v. pp. 207–254; translated by W. S. Dallas, F.L.S.

Placing at the head of them, as is customary, the name of Aristotle, even this "father of natural history" was quite in doubt as to the nature of the sponges; for while, in many passages, he describes the sponges known to him as animals, he regards them in another place as plants, and in a third refers them to those indifferent organisms which constitute the gradual and imperceptible transition from the animal to the plant.

Linné, who regarded all the sponges known to him as species of a single genus, *Spongia*, placed them, in 1735 (in his 'Systema Naturæ'), at the end of the vegetable kingdom, below the lowest Cryptogamia, combining them with the corals and coralliform Bryozoa as Lithophyta. Even in the tenth edition of his 'Systema Naturæ' (1760) this view is maintained. But in the twelfth edition (1767) he adopts the views of Ellis and Pallas, who had in the meanwhile declared the sponges to be animals, and placed them with the corals, among the Zoophyta.

Of those naturalists who even subsequently regarded the sponges as plants, Spallanzani, Sprengel, and Oken are especially to be noted; and this opinion has been held, even up to the most recent period, by Burmeister and Ehrenberg. Nevertheless the sponges have pretty generally passed as *animals* since Grant, in 1826, thoroughly described the canal-system of the sponges with its "pores" and "oscula," and also ascertained their reproduction by means of ciliated free-swimming larvæ.

With regard to the position occupied by the sponges in the system of animals, two different views especially stand at present in opposition to one another, and have done so for more than twenty years. In conjunction with Cuvier, most zoologists regarded the sponges as the nearest allies of the corals or polypes, and referred them, with these, to the primary division of the Radiata. The determining motive for this position was not, however, the recognition of the actual agreement of the sponges and corals in their most essential characters of organization, but rather the external similarity which exists between many sponges and corals in outward habit, and especially in the mode of stock-formation. But when, about a quarter of a century ago, it began to be perceived that the so-called "Radiate type" was a confusedly mixed assemblage of very various lower animals, and when, afterwards, as the recognition of their differences of organization advanced, the Radiata were divided into the three quite different main groups of the Echinodermata, Cœlenterata, and Protozoa, the sponges were not left with the corals or Anthozoa among the Cœlenterata, but degraded into the lowest section of the animal kingdom—a particular place being assigned to them, with the Infusoria and Rhizopoda, among the Protozoa.

The accurate investigations of the minute organization of the sponges which have been made since 1848, with improved microscopic appliances, and in accordance with the requirements of modern anatomy, appeared at first to fix this last position afresh. The very careful anatomical investigations of Carter in the East Indies (from 1848) and of Lieberkühn in Berlin (from 1856) seemed concordantly to lead to the result that the sponges were true Protozoa, and possessed close relations of affinity, on the one hand, to the Rhizopoda, and especially to the Amœbæ, and, on the other, to the true Infusoria (Ciliata) and to the Flagellata. In particular the structure of the parts of the siliceous skeleton of the siliceous sponges was compared to that of the similar and often scarcely distinguishable siliceous formations of the Sphærozoa and other Radiolaria. Moreover certain isolated sponge-cells were not to be distinguished from Amœbæ. The isolated ciliary cells from the canal-system of the sponges, which bear only one long whip-like cilium, resembled the individual Flagellata. Whilst thus the relationships of the sponges to the other Protozoa were sought in various directions, on the other hand the characteristic canal-system of the sponge-body could not but appear as a higher organic contrivance, which was entirely wanting in the other Protozoa, or at the utmost admitted of a very distant physiological comparison with the contractile vesicle of the Infusoria and Amœbæ. Hence, in proportion as more extended investigations revealed the multifarious modifications of this canal-system in the various groups of sponges, the opinion became more and more general that this was a quite peculiar vascular apparatus, and that the whole class of sponges was in consequence to be regarded as a class of animals *sui generis*, which stood in no near relations of affinity to any other class, either among the Protozoa or among the Cœlenterata.

This opinon, which is now predominant, that the peculiar canal-system of the sponges represents a perfectly specific nutritive apparatus, such as occurs in no other animals, and that, consequently, the Spongiæ are to be regarded as a peculiar and isolated class of animals *sui generis*, was expressed even by Grant (1826) and Johnston (1842), and has been maintained in recent times, especially by those zoologists who have gained most credit for the classification of sponges, namely, Oscar Schmidt and Bowerbank. The further the systematic investigations of the latter extended, and the more the minute structure of the sponges has been made known of late by the researches of Lieberkühn and Kölliker, the more did this isolated position of the class of sponges with its specific "water-vascular system" appear to be established.

In opposition to this predominant conception, only a few naturalists have of late adhered to the older opinion, that the Spongiæ were of all animals most nearly allied to the corals. Among these few Leuckart is especially to be noted. In 1854 he directly asserted the relationship of the sponges and polypes (corals) in the following words:—"If we imagine a polype-colony with imperfectly separated individuals, without tentacles, stomachal sac, and internal septa, we have in fact the image of a sponge with its large 'water-canals' opening outwardly." Leuckart accordingly placed the sponges in the system with the corals, in the natural primary group of the Cœlenterata, the typical arrangement of the organization of which he had been the first to recognize, in 1848, in their gastrovascular apparatus, the "cœlenteric canal-system." He did not, however, either then or afterwards, adduce any further proof of the near relationship of the sponges and corals, or demonstrate in detail the homologies actually existing between the two classes.

When I was staying, for three months, in the winter of 1866-67, upon the Canarian island of Lanzarote, I induced my travelling companion and pupil, M. Miklucho-Maclay, of St. Petersburg, to investigate thoroughly the extraordinarily rich sponge-fauna which we met with upon the lava-blocks of Puerto del Arrecife, the harbour of the island. The most important result of these spongiological investigations, of the correctness of which I have repeatedly convinced myself by my own observations, was the fact that the sponges stand in a much nearer relationship to the corals than has been previously admitted, and even than Leuckart had supposed. In particular, it appeared, from Miklucho's investigations, that the "perfectly peculiar" canal-system of the sponge-body was by no means such a peculiarly specific arrangement, but rather equivalent in general, both in form and function, to the gastrovascular system or cœlenteric apparatus of the Cœlenterata, and especially of the corals; in fact that this "nutritive system" is both homologous and analogous in the two classes. I was able the more impartially to recognize this highly important fact, by which the true affinity of the Spongiæ and Cœlenterata is definitively established, because previously, following the prevailing opinion, and supported particularly upon the views of Lieberkühn and Oscar Schmidt, I had regarded the sponges as peculiar Protozoa, most nearly allied to the Rhizopoda, and had placed them, in my 'General Morphology,' in the indifferent kingdom of the Protista.

Miklucho has published the most important results of his researches in his "Beiträge zur Kenntniss der Spongien," which appeared in 1868 in the fourth volume of the 'Jenaische Zeitschrift' (pp. 221–240, pls. 4 & 5). They relate chiefly to the remarkable *Guancha blanca*, a small calcareous sponge, which is to be reckoned one of the most interesting forms of the whole animal kingdom; for it forms small stocks (*cormi*), the constituent individuals (*persons*) of which belong, according to their structure, to different genera, and even different families, of the Calcispongiæ, and nevertheless grow forth from one and the same root.

Miklucho's remarkable observations on *Guancha blanca*, of the accuracy of which I constantly convinced myself with my own eyes while in Lanzarote, induced me last winter to submit to a comparative examination the numerous small calcareous sponges which I had previously collected in the North Sea at Heligoland, and in the Mediterranean at Nice, Naples, and Messina. Subsequently I also found some interesting small calcareous sponges on stones, univalve shells, and algæ, which I had collected, during my return journey from the Canary Islands, on the north-west coast of Africa, near Mogador, and in the Straits of Gibraltar, near Algeçiras, and brought with me well preserved in spirits. To this rich material of my own was added the calcareous sponges of the Zoological Museums of Edinburgh, Berlin, Munich, and Hamburg, which MM. Allman, Peters, Von Siebold, and Bolau were kind enough to send me. Through M. Schmeltz, I obtained from the Godeffroy Museum a number of interesting Australian calcareous sponges from Bass's Straits. My honoured friend and colleague, Professor Oscar Schmidt of Gratz, was good enough to send me specimens of the greater part of the calcareous sponges collected by him in the Adriatic. How abundant was the material thus placed at my command may be best learnt from the fact that I have been able to distinguish no fewer than 42 genera and 132 species among the Calcispongiæ.

I shall give exact descriptions and figures of these calcareous sponges, increased by a number of new forms which I expect to have sent to me by various colleagues, in the special part of my monograph of the Calcispongiæ, now in course of preparation. In the general part of this monograph I shall give a detailed exposition of the general natural history of the Calcispongiæ, which, I hope, will advance not only the knowledge of this little group, but in many respects that of the sponges in general. For although the legion of the Calcispongiæ is one of the smallest legions of the class of sponges, and, moreover, for the major part, contains exceptionally small, nay, even microscopic forms, it is nevertheless capable, more than all other sponges, of throwing a valuable general light upon the conditions of organization and affinity of the whole class. Moreover the special systematic and morphological relations of this small order are so simple and clear, and the genealogical relationships of its different genera and species so instructive and interesting, that a thorough elucidation of them is of great importance even to the general classification of organisms.

As the most important result of my investigations, I start with the following general proposition :—The sponges are most nearly allied to the corals of all organisms. Certain sponges differ from certain corals only by a less degree of histological differentiation, and especially by the want of urticating organs. The most essential peculiarity of the organization of sponges is their nutritive canal-system, which is both homologous with and analogous to the so-called cœlenteric vascular system, or gastrovascular apparatus of the Cœlenterata. In the sponges, just as in the corals, and, indeed, in the Cœlenterata generally, all the different parts of the body originate by differentiation from two primitive simple formative membranes or germ-lamellæ, the entoderm and the ectoderm. These two lamellæ originate by differentiation from the originally homogeneous cells which (having been produced by the segmentation of the ovum) compose the spherical body of the ciliated embryo or of the primitive larva (*Planula*). From the inner or vegetative germ-lamella, the entoderm, originate the nutritive epithelium of the canal-system and the reproductive organs. From the outer or animal germ-lamella, the ectoderm, all the other parts originate.

Before I proceed to support this proposition by a brief statement of the results of my observations, I may be permitted to make a few remarks upon the position which, in accordance with it, the sponges will henceforward have to occupy in the system of the animal kingdom, beside or below the Cœlenterata. For as we must infer, from the general homology which exists between all parts of the sponge- and coral-organisms, not merely an apparent anatomical agreement, but an actual blood-relationship of the two classes of animals, the question forces itself upon us, with respect to the system, what particular place the sponges will have to take in the existing classification of the Cœlenterata.

In recent zoological systems the stem or type of the Cœlenterata is pretty generally divided into three classes :—1. Corals (Polypes or Anthozoa) ; 2. Hydromedusæ (Hydroida and

Medusæ); 3. Ctenophora (Ciliograda). All the animals of these three classes agree not only in the characteristic formation of the nutritive vascular system, but also in the possession of urticating organs, for which reason Huxley grouped them together as Nematophora. These characteristic urticating organs are entirely deficient in all true sponges. The absolute *deficiency of the urticating organs in all sponges*, and their constant presence in all corals, Hydromedusæ, and Ctenophora, is at present the *sole morphological character* which sharply and decidedly separates the first class from the last three. I have therefore, in my 'Monograph of the Monera,' and subsequently in my 'Natural History of Creation,' included the three last-mentioned classes under the old name of *Acalephæ* or *Cnidæ* (nettle-animals). Even Aristotle comprehended under this denomination the two characteristic primary types of the group, the free-swimming *Medusæ* and the sedentary *Actiniæ*. Moreover the distinctive character of the nettle-animals, namely the possession of urticating organs, is just as clearly expressed by this denomination as by Huxley's name Nematophora.

We should therefore have to divide the stem or phylum of the Zoophytes (*Cœlenterata* s. *Zoophyta*) into two primary groups (subphyla or cladi)—1, Sponges (*Spongiæ* s. *Porifera*), and, 2, Nettle-animals (*Acalephæ*, s. *Cnidæ*, s. *Nematophora*). The latter would divide into the three classes of the Corals, Hydromedusæ, and Ctenophora. Among the sponges we might *provisionally* distinguish as two classes the *Autospongiæ* and the fossil *Petrospongiæ*, as hitherto these two groups have not allowed themselves to be brought into near connexion either in the whole or in detail. Among the Autospongiæ the *Calcispongiæ* would form a distinct subclass or legion.

We might perhaps go even further, and, supported by the very near relations of affinity of the sponges and corals, speak in favour of the following division of the Cœlenterata:—

Cladus I. Bush-animals (THAMNODA).

- Class 1. Sponges (*Spongiæ*).
- Class 2. Corals (*Corallia*).

Cladus II. Sea-jellies (MEDUSÆ).

- Class 1. Umbrella-jellies (*Hydromedusæ*).
- Class 2. Comb-jellies (*Ctenophoræ*).

Time only can decide which grouping best corresponds to the natural relationships, when the genealogy of the

Cœlenterata can be more completely established upon the basis of extended ontogenetic and comparative anatomical investigations.

That the essential agreement in the internal organization of the sponges and corals, their actual homology, has hitherto been for the most part overlooked is due, among other things, to the fact that the most accurate anatomical investigations of recent times (especially those of Lieberkühn) took their start from the two best-known and commonest forms of sponges—namely, the freshwater sponge (*Spongilla*), which belongs to the group of the true siliceous sponges, and the common sponge (*Euspongia*), belonging to the group of horny sponges. But these very two forms of sponges differ in many respects considerably from the original and typical structure of the entire class, have been in many ways modified and retromorphosed by adaptation to special conditions of existence, and therefore easily lead to erroneous conceptions, especially as their investigation is comparatively difficult.

On the other hand, among all the sponges, no group appears better fitted to shed full light upon the typical organization and the true relations of affinity of the whole class than the legion of the Calcispongiæ. Lieberkühn has already expressly acknowledged this in his 'Beiträge zur Anatomie der Kalkspongien' (1865), and endeavoured, from the results obtained from the Calcispongiæ, to render the other sponges more intelligible.

This applies in the first instance even to the *individuality* of the Calcispongiæ, which is adapted, in a far higher degree than that of most other sponges, to elucidate the difficult tectology or theory of individuality of the sponges. Reserving the circumstantial statement of these conditions, which are equally interesting and important, for my monograph of the Calcispongiæ, I will here cite only the result of my special investigations upon this point. This consists essentially (leaving out of consideration some modifications) in a confirmation of the opinion quite recently put forward by O. Schmidt, that every part of the sponge-body which possesses an excurrent orifice (*osculum*) is to be regarded as a distinct "individual." This "true individual" of the sponge-body I denominate, in accordance with my theory of individuality, a "person;" and every sponge-body that consists of two or more persons (*i. e.* that possesses two or more oscula) I denominate a "stock" or "cormus." The special limitation of these two ideas, which are rendered necessary by the peculiar conditions of individuality of the sponges, I reserve for my monograph. There are consequently simple (solitary or monozoic) and compound (social or polyzoic) sponges. Of simple sponges or persons we have examples in *Sycum* and *Ute* among the calcareous sponges, *Caminus* among the bark sponges, and *Euplectella* among the siliceous sponges. On the other hand, *Leucosolenia* and *Nardoa* among the calcareous sponges, *Euspongia* among the horny sponges, and *Spongilla* among the siliceous forms are compound sponges or stocks.

I do not, like most other authors, regard the characteristic canal-system of the sponges as something quite specific and peculiar to this class, an arrangement *sui generis*, but share in the opinion of Leuckart and Miklucho, that it is essentially *homologous with the cœlenteric vascular system* or gastrovascular apparatus of the corals and Hydromedusæ—in fact, of all the Acalephæ or nettle-animals. Indeed I am so thoroughly convinced of this homology that I (with Miklucho) designate the largest cavity into which that canal-system is dilated in the sponge-body, and which is usually called the excurrent tube or flue (*caminus*), as the *stomach*, or digestive cavity, and its outer orifice, which is usually called the excurrent orifice or osculum, as the buccal orifice or mouth.

In opposition to this conception two objections especially will be urged—namely, in the first place, that there are sponges with no flue and osculum, and, secondly, that the direction of the flow of water in the sponge-body is not reconcilable with it. As regards the first objection, I think I can invalidate it by a simple reference to developmental history. The sponges without flue and without osculum are either primitive sponge-forms, whose ancestors had never attained to the differentiation of this central part of the canal-system, or they are retromorphosed forms whose ancestors have lost stomach and mouth by phyletic degeneration. The latter stand in the same relation to the more highly developed sponges furnished with mouth and stomach as the Cestode worms to the Trematoda. The Cestoda (in consequence of their stronger adaptation to the parasitic mode of life) have also lost the intestine and mouth, which their trematodiform ancestors possessed. Most of the mouthless sponges, such, especially, as the *Clistosyca* and *Cophosyca* among the Calcispongiæ, are probably to be regarded as such retromorphosed, and not as originally astomatous forms; and if their embryos, which are still unknown to us, actually acquire a mouth and stomach like the other sponge-embryos, this ontogenetic fact would most decidedly confirm our phylogenetic hypothesis. *Sycocystis*, the young form of which is provided with a mouth, while the mature form is astomatous, may even now be cited in its favour.

The *physiological conditions of the water-circulation in the* *sponge-body* seem to constitute a more substantial objection to our interpretation. It is well known that generally (but not always!) the direction of the flow of the water which passes through the canal-system of the living sponge-body is as follows:—The water flows in through very numerous and fine *cuticular pores* (the so-called "incurrent apertures"), usually perceptible only by means of the microscope, and through these fine "incurrent canals," which often ramify and anastomose repeatedly, reaches a few larger canals, which finally open into the central "excurrent cavity" (our "stomachal cavity"). From this the used water then escapes outwards with the useless solid particles through the "excurrent orifice" (our "mouth").

In the corals or Anthozoa, on the other hand, as also in the other Cnidæ, the direction of the flow of the water which traverses the cavities of the body appears to be different, and in a certain sense opposed to the ordinary direction of the current in the sponges. The water, which at the same time conveys the food into the body, is usually, in the Cnidæ and, especially, in the corals, taken up by the mouth, passes through this into the stomach, and hence into the other canals which traverse the body. The part played in this process by the cutaneous pores of the corals is unfortunately still as good as unknown. These fine apertures in the skin, usually perceptible only through the microscope, through which the finest canals of the cœlenteric vascular system open outwards in the corals, just as in the sponges, have by no means attracted so much attention in the former as in the latter. Nay, they have scarcely even been compared! Whilst the greatest importance has been attached to the cutaneous pores of the sponges, those of the corals, although long known, have been almost universally ignored; and yet the two are evidently *homologous*, and of one and the same origin! Nay, it is even very possible (not to say probable) that through the skin of the corals, as through that of the sponges, respiratory currents of water constantly penetrate into the body by means of the cutaneous pores, and that these traverse the canals of the body-wall, and finally discharge themselves into the stomachal cavity. The cutaneous pores in the corals might then, just as much as in the sponges, be designated "incurrent apertures."

So much, at any rate, is certain, that an essential *morphological* difference does *not* exist between the nutrient vascular system of the sponges and corals. If we compare single, solitary, perfectly developed persons of the two classes, *e. g. Sycum* and *Actinia*, we find in both a central cavity as the true principal part of the nutrient canal-system—a central cavity (flue or stomach) which opens outwards by a single large orifice (osculum or mouth). From this cavity canals issue in all directions, which traverse the body-wall, and finally open on their surface by the cutaneous pores. If, on the other hand, we compare a sponge-stock (e. g. *Sycodendrum*, *Spongilla*) and a coral-stock (e. g. *Dendrophyllia*, *Gorgonia*), we find in like manner, in both, a nutrient canal-system of the cœnenchyma or cœnosoma, which places the cavities of the individual persons in communication with each other.

The difference in the direction of the current of water which is usually admitted in the two classes is a matter of perfect indifference in this close *morphological* comparison. Even if this difference was really constant, general, and thoroughgoing, it would not be capable of invalidating our notion of the homology of the canal-system in the body of the sponge and coral. The difference in the circulation of the nutrient stream of water in the two classes of animals would merely prove that no *physiological* comparison, no *analogy*, exists between the individual parts of the vascular system, but that this has rather been lost by *adaptation* to different conditions of nutrition. But by this our *morphological* comparison of the corresponding parts, their *homology*, which we must ascribe to inheritance from common ancestors, is in no way affected. But when we have to grasp the true relation of affinity of two groups of animals, we must consider only their actual homologies, *i. e.* those similarities arising from common inheritance, which alone constitute the true guiding-star in every comparative exposition. On the other hand, we must leave entirely out of consideration the *analogies* which depend upon mere *adaptation*, because these are much better fitted to obscure and conceal than to illuminate and clear up this relation of affinity.

But it must be pointed out that this contrast in the direction of the current of water, which is almost universally assumed to occur in the vascular system of the sponges and corals, and regarded as without exception, is by no means an absolute and unfailing one. Miklucho has already shown that in a great many sponges the mouth or osculum by no means permits only the outflow, but also the inflow of water. I have repeatedly convinced myself, by my own observations, of the correctness of this assertion. Consequently the mouth in many sponges, just as in the corals, serves for both the reception and expulsion of the water and the nutritive constituents contained in it.

For the right understanding of these relations, those sponges which have no cutaneous pores at all, and in which the sole aperture of the perfectly simple stomachal cavity is the osculum or mouth, are of peculiar importance. Such a *sponge without cutaneous pores*, and the entire cœlenteric canal-system of which consists, as in *Hydra*, of a perfectly simple stomachal cavity with a simple mouth-orifice, was believed by Miklucho to be presented in his *Guancha blanca.* I have, however, by subsequent careful examination of the forms of *Guancha* collected by Miklucho himself and handed over to me, ascertained that this sponge possesses simple cutaneous pores. On the other hand, I have examined two microscopically small, but yet perfectly developed (*i. e.* ovigerous), calcareous sponges collected by me in Naples, in which there are actually no traces of cutaneous pores. The entire body of these most primitive forms of Calcispongiæ consists of an elongate rounded sac (stomach), with a single opening (mouth) on that extremity of the body which is opposite to the point of attachment. For this extremely interesting primitive form, which must evidently open the series of the Calcispongiæ, I propose the name of *Prosycum.*

But full light is thrown upon these, as upon all other organic relations, only by *developmental history.* The earliest young forms of the sponges, the ciliated embryos, which afterwards swarm about freely as larvæ by means of their ciliary coat, diffuse this light in the most desirable manner. I have traced the ontogeny of these youngest forms (which were previously known among the Calcispongiæ only in *Sycum* and *Dunstervillia*) in a number of quite distinct genera, and have by this means arrived at the following results, which in part confirm, and in part essentially enlarge, the existing observations on the ontogeny of the sponges.

After the egg has been broken up, in consequence of the process of segmentation, into a spherical, mulberry-like aggregation of closely adpressed, homogeneous, naked spherical cells, the mulberry-like embryo, by stronger growth in one direction, acquires an ellipsoidal or oval form, and covers its surface with cilia. A small central cavity (stomach) is then produced in its interior; this extends, and, breaking through at one pole of the longitudinal axis, acquires an aperture, the mouth.

Either before the buccal orifice of the stomach is perforated, or at any rate soon afterwards, the free-swimming, ciliated larva of the calcareous sponges sinks to the bottom of the sea and attaches itself there. The point of adhesion is usually situated at the pole of the longitudinal axis which is opposite to the mouth (aboral pole). The body of the young sponge now forms a simple, elongate rounded, adherent sac, the cavity of which communicates with the surrounding sea-water only by a single aperture, the mouth, placed opposite to the point of attachment. *In this early young state*, when it constitutes a simple cup-shaped body with solid walls and a simple aperture, *the young sponge is not essentially different from a young coral* which is still in the same early period of ontogenesis. But just as the common freshwater Polype (*Hydra*) presents persistently throughout life, in its simple sac-like body-cavity, a similar cœlenteric primitive state to that which all corals pass through in their youth, so does this just-mentioned simplest calcareous sponge (*Prosycum*) remain throughout its life, until perfect maturity, in the same cœlenteric primitive state which the other calcareous sponges have to pass through rapidly in their earliest youth. Considering, now, that extremely important and intimate *causal connexion* which everywhere exists between *ontogeny* and *phylogeny*,—considering the morphogenetic fundamental law, that the *ontogeny* (that is to say, the individual developmental history of the organism) constitutes a short and rapid (causally conditioned by the laws of inheritance and adaptation) repetition of its *phylogeny*, that is, of the palæontological developmental history of the ancestors of its entire stock,—considering this high phylogenetic signification of all ontogenetic states, we must, from these simple facts, from this ontogenetic concordance between the young states of the sponges and corals, draw the extremely important phylogenetic conclusion, that *the sponges and corals are near blood-relations*, whose origin is derived from one and the same original common stock-form. This unknown stock-form, of whose special structure no fossil remains are preserved to us from the archolithic period of the earth's history, but as to whose former existence we may conclude with perfect certainty from the adduced facts, nay, of whose general form we have even still an approximate picture in *Prosycum simplicissimum*!, must have possessed a simple cup-shaped body, with a single orifice placed opposite to its point of attachment. We will give this the name of the primitive sac, Protascus. From this hypothetical *Protascus* probably originated, as two divergent branchlets, *Prosycum* (the stock-form of the Calcispongiæ) and *Procorallum* (the stock-form of the corals).

[To be continued.]

II.—*On the Species of the Genus* Philhydrus *found in the Atlantic Islands.* By D. Sharp, M.B.

When engaged last spring in making an examination of our British *Philhydri*, and comparing them with the few specimens in my possession of the same genus from other parts of the world, I was surprised to find, amongst some material which had been collected in the Canary Islands by the Messrs. Crotch, examples of the *P. maritimus*, Th., which in no way differed from our British individuals of that species. As the *P. maritimus* is not included in Mr. Wollaston's 'Coleoptera Atlantidum,' I communicated the fact in a letter to that gentleman; and in return he kindly sent to me for examination such specimens of *Philhydrus* from the Madeiran, Canarian, and Cape-Verde archipelagos as were still accessible to him; and as we have found two species amongst them which are apparently undescribed, and have ascertained also that the one which he had regarded as the *melanocephalus* of Olivier is better identified with what I believe to be Küster's *politus*, found in Mediterranean latitudes, I have thought that it might not be amiss to call attention to the several species, collectively, which have hitherto been observed in those islands. I regret, however, that I have not sufficient examples before me to enable me in *every* case to decide positively whether certain forms should be treated as distinct species or not; and in order therefore to avoid encumbering the Atlantic Catalogue unnecessarily, I have regarded all such doubtful ones as *varieties*, and thus can distinguish with *certainty* but four species, which are as follows:—

1. *Philhydrus maritimus*, Th., Sk. Col. ii. p. 96 (1860).

The entirely pale upper surface of this species, as well as the stronger punctuation of its elytra, are characters amply sufficient to distinguish it at a glance from any of the following.

Inhabits the Canarian archipelago, a few examples of it having been found by the Messrs. Crotch in Gomera.

2. *Philhydrus politus*, Küst., Käf. Eur. 18. 9 (1849).

P. oblongo-ovalis, convexus, nitidus, niger, prothoracis elytrorumque marginibus fusco-testaceis, capite maculis duabus ante oculos, tarsis, antennis (clava excepta) palpisque rufo-testaceis, his articulo secundo basi infuscato; prothorace crebre subtiliter punctato; elytris parce subtilius punctatis, seriebus tribus punctorum majorum impressis.

Long. fere 3 lin.

Mas tarsorum unguiculis fere angulatim curvatis, basi dente valido instructis.

Fœm. tarsorum unguiculis basi dente minore instructis.

Inhabits the Madeiran and Canarian archipelagos, the exact form defined above (which I have regarded as the *type*) having been met with by Mr. Wollaston in Teneriffe and Gomera, of the Canarian group, in the latter of which islands it was found likewise by Messrs. Gray and Crotch.

Var. β paulo angustior, prothorace obsoletius punctato, palpis articulo secundo haud infuscato, tibiis piceo-rufis. Long. $2\frac{3}{4}$ lin.

Inhabits the Canaries, the single example (before me) which I have described as the "var. β," having been taken by Mr. Wollaston in Fuerteventura.

Var. γ supra fusco-testaceus, prothoracis limbo dilutiore, capite nigro maculis duabus magnis rufo-testaceis, palpis articulo secundo basi infuscato, tibiis tarsisque fusco-testaceis. Long. fere 3 lin.

Inhabits the Canaries, having, like the "var. β," been found by Messrs. Wollaston and Gray in Fuerteventura.

Var. δ "var. γ" similis, prothorace elytrisque magis infuscatis, palpis totis testaceis. Long. vix $2\frac{3}{4}$ lin.

Inhabits the Madeiran archipelago, having been captured by Mr. Wollaston abundantly in the island of Porto Santo, where it swarms along the edges of the half-dried brackish streams.

I hope I may prove correct in referring the type of this apparently variable species to the *P. politus*, Küst. Küster's description, however, indicates the sculpture of the elytra as much more distinct than it would appear to be in the Atlantic examples before me. But I have, at any rate, Spanish ones from Carthagena (the very locality from which Küster's specimens of *P. politus* were obtained) agreeing in every respect with the particular form from the Canary Isles which I have above regarded as the *type* of the species.

A specimen of the "var. δ" was many years ago identified by Dr. Aubé as *P. melanocephalus*, Oliv., from which species nevertheless it is entirely distinct. On the strength, however, of this determination, Mr. Wollaston admitted *P. melanocephalus* into his list of Atlantic Coleoptera; but in reality we have no evidence as yet of its occurrence in any of those sub-African islands. The description of *P. atlanticus*, Blanchard, in 'Voy. au Pôle sud,' Zool., tome iv. p. 51 (A. D. 1853), I am unable to refer with certainty to any species or variety at present before me; but it is said to inhabit Teneriffe.

I would also remark that it is not altogether impossible that some one (or perhaps more) of the forms which I have here treated as varieties of *P. politus* may prove eventually to be a distinct species.

3. *Philhydrus Wollastoni*, n. sp.

P. subovalis, sat convexus, nitidus, piceo-niger, prothoracis elytrorumque limbo dilutiore, capite maculis duabus parvis ante oculos, palpis antennarumque basi testaceis, pedibus piceo-rufis; capite prothoraceque crebre subtiliter, elytris parcius obsoletiusque punctatis, his seriebus tribus punctorum majorum impressis.
Long. $2\frac{1}{2}$ lin.

Inhabits the Cape-Verde archipelago, having been found by Messrs. Wollaston and Gray in the islands of S. Antonio, S. Vicente, S. Iago, and Brava—in the first of which it was met with likewise by Dr. H. Dohrn.

Var. β paulo brevior et magis convexus, colore dilutiore, palpis paulo brevioribus et crassioribus.

Found in S. Antonio, this very slightly different form being the one which is distinctive of that island.

Nearly as large as the northern *P. melanocephalus*, but darker and more uniform in colour, with its elytra sparingly and much more indistinctly punctured, and with the claws of its tarsi much smaller and scarcely differing in structure in the two sexes,—in which last respect it resembles *P. ovalis*, Th., and *marginellus*, Fab., and differs decidedly from *P. politus*, Küst., and *maritimus*, Th.

4. *Philhydrus hesperidum*, n. sp.

P. oblongo-ovalis, leviter convexus, nitidus, capite nigro, maculis duabus parvis ante oculos, antennarum basi palpisque testaceis, his apice summo subinfuscato; prothorace disco piceo-nigro, marginibus testaceis; elytris fusco-testaceis, parce obsoleteque punctatis, seriebus tribus punctorum majorum impressis; pedibus piceis, tarsis dilutioribus.
Long. $1\frac{1}{2}$–2 lin.

Inhabits the Cape-Verde archipelago, having been detected by Messrs. Wollaston and Gray in S. Antonio, S. Vicente, S. Iago, and Brava.

Closely allied in form and appearance to the European *P. marginellus*, but not quite so large as that species, and at once distinguishable from it by its very sparingly and obsoletely punctured elytra. It pretty closely resembles *P. Wollastoni*; but its smaller size and more oblong form, as well as several differences in the details of its colour and punctation, will suffice to distinguish it.

III.—*On a Byssiferous Fossil* Trigonia. By John Lycett, M.D.

The discovery of a byssal aperture in a fossil *Trigonia*, in connexion with certain features which are presumed to have been physically connected with such a condition of existence, is a novelty in fossil zoology, and, as such, needs no apology, although the species was figured and partially described upwards of twenty-eight years since. I allude to *Trigonia carinata*, Agassiz, found in the Lower Greensand of various French and English localities. The well-known memoir by Agassiz on the genus *Trigonia* contains figures of this species representing merely immature casts, in which the ornamentation of the surface is only very imperfectly indicated; and the description also accords with such an unsatisfactory condition. D'Orbigny, in his 'Paléontologie Française,' has given elaborate figures of a single perfect specimen of adult or nearly adult growth. Upon referring to plate 286 of the work last cited, we find a marvellously perfect example of *T. carinata*, possessing all the usual sectional characters of the *costatæ*, remarkable more especially for the salient ornamentation of the area, with its large carinæ and intermediate costellæ: these features, so beautiful in the earlier stage of its growth, disappear altogether in specimens that have attained to about half the dimensions of adult shells, and are replaced by irregular, large, rugose, transverse plications; but in the figures of D'Orbigny we discover nothing of this: the area retains its pristine ornamentation unaltered to its ultimate stage of growth—a condition of existence which we may never expect to discover in any actual specimen. The same figures have no indication of a byssal aperture, and the costæ have less than their real obliquity. The author's text is only a brief description *of the figures of the artist.*

The general figure of *T. carinata* is remarkable as compared with examples of the genus generally; it is oblong or ovately oblong, much lengthened and narrow or inflated along its mesial portion, and has in fact much general resemblance to *Byssoarca*. The byssal aperture is not large, and is placed at the anterior or antero-inferior border. An examination of the lines of growth shows that this orifice was formed only when the valves approached to their adult condition. Specimens which exhibit the complete or uninjured outline of the valves are all of immature growth, and had not formed the byssal aperture. Valves of adult growth are found in a condition altogether different and in accordance with the altered habits of the mollusk: the lively bivalve, with its saltatory motions, had then become sedentary, and lay moored to a rocky surface, or was partially buried in its sandy matrix; in such a position its upper or more exposed surface consisted of the posteal half of the area; and this portion, either exposed or discovered by the motion of the excurrent and incurrent siphons, invariably became a prey to the marine flesh-eaters: a portion more or less large is always found broken away and removed. The whole general aspect of the adult valves exhibits that worn or abraded condition with which we are also familiar in *Byssoarca*, and doubtless resulted from similar causes in both instances.

I hope to present faithfully executed figures of this byssiferous *Trigonia* in a Monograph on the British Trigonias, now in preparation for the Palæontographical Society.

IV.—*On the Coleoptera of St. Helena.* By T. Vernon Wollaston, M.A., F.L.S.

[Concluded from vol. iv. p. 417.]

Fam. 19. **Anthribidæ.**

(Subfam. Aræocerides.

Linea transversa prothoracica *basilaris*, marginem ipsum basalem elevatum efficiens.)

Genus 35. Aræocerus.

Schönherr, Curc. Disp. Meth. 40 [script. Aræcerus] (1826).

52. *Aræocerus fasciculatus**.

A. breviter ovalis, crassus, brunneo-piceus, pube brevi squamæformi demissa cinerea griseaque vestitus necnon in elytris plus minus obsoletissime (sc. in interstitiis alternis) longitudinaliter tessellatus; capite prothoraceque (subter pube) opacis, densissime et rugose punctatis, illo in medio tenuiter carinulato oculis maximis prominentibus, hoc subconico, postice lato bisinuato, costa transversa in marginem basalem coëunte necnon utrinque marginem lateralem (usque ad medium lateris ductum) efficiente, angulis posticis subrectis; elytris apice truncato-rotundatis, (subter pube) subopacis, densissime et rugose granulatis ac leviter crenulato-striatis; antennis pedibusque elongatis et (præcipue illis) gracilibus, illis rufo-testaceis clava obscuriore, his rufo-ferrugineis, tarsorum art° 1^{mo} longissimo.

Long. corp. lin. 2–$2\frac{1}{3}$.

Curculio fasciculatus, De Geer, Ins. v. 276, t. 16. f. 2 (1775).
Anthribus coffeæ, Fab., Syst. Eleuth. ii. 411 (1801).

Two examples of an *Aræocerus*, which were taken at St. Helena by Mr. Melliss, I feel almost confident are referable to the *A. fasciculatus* (which is usually known in collections as the *coffeæ* of Fabricius), though I have thought it desirable to give a careful diagnosis of them, in the event, perhaps, of their being identified hereafter with some cognate form. The insect, however, is evidently a variable one; and there are individuals in the British Museum, bearing the label "*coffeæ*," which seem in no way to differ from the pair now before me; whilst the fact that the species (the larva of which appears to subsist within various seeds and berries which are used as articles of food) has become naturalized, through the medium of commerce, in most of the warmer countries of the civilized world would go far to render it probable that the St.-Helena one is the true *fasciculatus*, and has been established in the island (as elsewhere) by indirect human agency.

With the exception of the *Notioxenus Bewickii*, the present insect is considerably larger than any of the other members of the *Anthribidæ* hitherto detected in St. Helena; and, apart from the greatly elongated first joint of its feet, and the fact of its transverse prothoracic keel being removed to the *extreme* base (so as to form a mere elevated margin to the pronotum), and then produced, at right angles, to about midway along the lateral edge (characters which are more strictly *generic* ones), it may be further recognized by its compact thickened body and short-oval outline, and by its brownish piceous surface being clothed with an abbreviated, decumbent, scale-like, cinereous pubescence, the alternate elytral interstices having additionally more or less obsolete indications of being obscurely tessellated, which, however, is sometimes scarcely traceable. Its eyes are large and prominent, its antennæ rufo-testaceous and extremely slender, and its surface, when the pubescence is removed, will be seen to be nearly opaque, and closely and coarsely sculptured.

(Subfam. NOTIOXENIDES.

Linea transversa prothoracica conspicue *ante basin* sita, utrinque plus minus arcuata sed nullo modo per marginem lateralem retrorsum ducta.)

Genus 36. NOTIOXENUS.

Wollaston, Journ. of Ent. i. 212 (1861).

Corpus vel oblongum vel ovato-oblongum, aut pubescenti-variegatum aut subglabrum, plus minus pictum: *rostro* brevi, triangulari, apice rotundato-truncato; *oculis* rotundatis, integris: *prothorace* subovato postice truncato, ante basin vel linea impressa vel (sæpius) carinula elevata, utrinque plus minus leviter arcuata, transversim instructo: *scutello* minutissimo, ægre observando: *elytris* ovalibus (rarius ovatis) basi truncatis, postice subabbreviatis (pygidium vix tegentibus) necnon ad apicem ipsum singulatim paulo rotundatis. *Antennæ* graciles, rectæ, in pagina superiore rostri (mox intra oculos in fovea) insertæ; art^{is} 1mo et 2do longiusculis (illo paulo robustiore curvato), 3^{tio} ad 8^{vum} longitudine subæqualibus, latitudine leviter crescentibus, reliquis clavam elongatam laxam sat abruptam pilosam 3-articulatam efficientibus (9no et 10mo intus obsolete subproductis, ult^{mo} subgloboso). *Pedes* breviusculi, subgraciles; *tibiis* rectis, ad apicem muticis; *tarsis* pseudotetrameris, art^{o} 1mo quam 2^{dus} in *anterioribus* vix sed in *posticis* multo longiore, 2do paulo latiore, ad apicem leviter emarginato, 3^{tium} latiorem bilobum recipiente; *unguiculis* appendiculatis.

I have thought it desirable to give a fresh (and slightly amended) diagnosis of this interesting genus, not merely on account of its extreme eccentricity, but because, in conjunction with *Microxylobius*, *Nesiotes*, and *Trachyphlœosoma*, of the *Curculionidæ*, it is amongst the most characteristic and truly indigenous of the Coleopterous forms which have hitherto been detected in St. Helena. Indeed it is difficult to overrate the importance, in a small insular catalogue, of a group like the present one—combining as it does the structural features of the *Anthribidæ* with the external outline and aspect of the genuine Curculionids; and I may add that the great specific dissimilarity of the four representatives enunciated below induces me to suspect still (as I did in 1861, when only two of them had been brought to light) that there are many *Notioxeni*, of a more or less intermediate *facies*, yet to be discovered, and for which therefore we may confidently look. Apart from its singular Curculionideous contour, *Notioxenus* is remarkable amongst its immediate congeners for (more especially) its transverse prothoracic keel being considerably removed from the immediate base of the prothorax, and for being replaced in one of the species (the *N. Bewickii*, which I have nevertheless regarded as the type of the genus) by an *impressed* line. In both instances, however, the line (whether channel or keel) is more or less arcuate, or very gradually and slightly curved towards either side; but it is *not* produced at right angles, in any degree whatsoever, along the lateral edges of the pronotum. The sculpture of the *Notioxeni* varies greatly, according to the species; but they appear to be *ornamented* with (sometimes obscure) patches and bands, either on the surface itself or (more often) produced by the short and somewhat paler decumbent pubescence with which they are more or less clothed. Whether they possess any saltatory power (as in *Aræocerus*) I have not yet been able to ascertain.

§ I. *Linea prothoracica* impressa, *canaliculum efficiens.*

53. *Notioxenus Bewickii.*

N. fusco-niger, subopacus, impunctatus sed minutissime obsoleteque subrugulosus, pube brevi squamæformi demissa grisea vestitus necnon hinc inde cinereo-pictus; capite distinctius ruguloso (fere etiam punctato), oculis magnis sed haud prominentibus; prothorace linea subbasali utrinque regulariter subcurvata impresso plagisque 3 longitudinalibus, plus minus obsoletis, fractis, cinereo-squamosis picto; elytris argute impunctato-striatis, maculis minutis plurimis cinereo-squamosis irroratis, ad basin et humeros interdum obsolete rufescentioribus; antennis gracilibus, rufo-testaceis, apicem versus infuscatis; pedibus fusco-piceis, genibus rufescentioribus, tarsis picescenti-testaceis.

Long. corp. lin. circa 3.

Notioxenus Bewickii, Woll., *loc. cit.* 213, pl. xiv. f. 1 (1861).

A most remarkable species, differing from the other *Notioxeni* hitherto detected not only in its much larger size and in its griseous-black, densely clothed surface, which appears to be obscurely ornamented with small and indistinct dull cinereous patches, but likewise (which is an extremely anomalous feature) in its subbasal prothoracic line being *impressed*, instead of raised. With the exception of the head, which is more coarsely sculptured, its surface is impunctate, though rather alutaceous and subopaque (as may be seen when the pubescence is removed); and its elytral striæ are also perfectly simple. The only two examples of this *Notioxenus* which have yet come under my notice were taken—one, in 1860, by the late Mr. Bewicke (to whom the species is dedicated), "amongst native vegetation on the extreme summit of the island," and the other, more recently, by Mr. Melliss.

§ II. *Linea prothoracica* elevata, *carinulam efficiens.*

54. *Notioxenus rufopictus.*

N. ater, nitidus, subcalvus (sc. pube brevi demissa fulvo-cinerea parcissime irroratus); capite prothoraceque sat rugulose punctatis, hujus linea subbasali elevata subrecta (i. e. utrinque vix curvata); elytris profunde crenato-striatis, interstitiis convexis, parce, minutissime et irregulariter punctulatis, maculis parvis plurimis (præsertim ad basin et versus latera) rufis aut testaceo-rufis (plus minus confluentibus) ornatis; antennis breviusculis, rufo-testaceis, apicem versus infuscatis; pedibus nigro-piceis, femoribus apicem versus genibusque rufescentioribus, tarsis picescenti-testaceis.

Long. corp. lin. circa 1¾.

Notioxenus rufopictus, Woll., *loc. cit.* 213, pl. xiv. f. 2 (1861).

The only example of this beautiful *Notioxenus* which I have yet seen was captured by the late Mr. Bewicke, during his few hours' collecting at St. Helena, on the 21st of July 1860, amongst native vegetation, on the extreme summit of the island. It is very much smaller than the last species, but rather larger than either of those which follow; and it may be further recognized by its black, shining, and comparatively unpubescent surface, by its strongly and closely punctured head and prothorax (the subbasal line of which is *raised*, as in the two following species, and hardly at all curved), and by the convex interstices, deep crenate striæ, and numerous bright red patches of its nearly glabrous elytra.

55. *Notioxenus dimidiatus*, n. sp.

N. subovatus, viridi- (immaturus piceo-) æneus, nitidus, pube grossa demissa cinerea parce vestitus; capite profunde rugoso-punctato; prothorace in disco antico levius parciusque punctato, linea subbasali subcurvata et valde elevata; elytris grosse striato-punctatis, punctis striisque (suturali profundiore basi evanescente excepta) in dimidia parte postica evanescentibus, margine basali ipsissimo rugose elevato; antennis picescentibus, apicem versus pedibusque (tibiis versus basin rufescentioribus exceptis) nigrescentibus.

Variat immaturus colore omnino pallidiore, etiam ænescenti-ferrugineo, elytrisque fascia media dentata obscura nigrescentiore ornatis.

Long. corp. lin. $1\frac{2}{3}$–$1\frac{3}{4}$.

This species appears to be a little more ovate, and perhaps also (on the average) a trifle smaller, than the *N. rufopictus*; and it is abundantly distinguished by its greenish-brassy, shining, and coarsely but sparingly pubescent surface, by its greatly elevated and evidently curved subbasal prothoracic line, and by the striæ and largely developed punctures becoming evanescent on the posterior half of its elytra. One of the two specimens now before me (and which were taken in St. Helena by Mr. Melliss) seems to be immature; for it is altogether paler (indeed well-nigh æneo-ferruginous), and there are indications on its elytra of an obscure, central, dentate, blackish fascia, which the darker surface of the other example appears to render quite untraceable.

56. *Notioxenus alutaceus*, n. sp.

N. viridi-æneus, subnitidus, alutaceus (sed haud punctatus), pube demissa fulvescente parce vestitus; prothoracis linea subbasali subcurvata elevata; elytris postice magis abbreviatis, striis (suturali profunda basi evanescente excepta) obsoletis; antennis piceis, basi rufo-testaceis; pedibus picescentibus, tibiis (tarsisque ad basin minus evidenter) dilute rufo-testaceis.

Long. corp. lin. vix $1\frac{1}{2}$.

Judging from the single example now before me, and which was found in St. Helena by Mr. Melliss, this would seem to be the smallest of the true *Notioxeni* hitherto brought to light; and whilst it agrees with the last species in its somewhat brassy-green hue, it recedes from it totally in its unpunctured, *alutaceous*, and less shining surface, and from *all* the others here enumerated in its elytra (which are a good deal shortened behind) being free from striæ, with the exception of a single deep one (evanescent anteriorly) on each alongside the suture.

(Subfam. Homœoderides.

Prothorax simplex, sc. linea transversa nulla instructus.)

Genus 37. Homœodera (nov. gen.).

Corpus et *instrumenta cibaria* fere ut in *Notioxeno*, sed *antennæ* aperte remotius ab oculis insertæ, *prothorax* simplex (nec linea basali instructus), atque *articulus primus tarsorum posticorum* minus elongatus.

Ab ὅμοιος, similis, et δέρη, thorax.

The *primâ facie* aspect of the three species described below is so much that of the smaller *Notioxeni* (the *N. dimidiatus* and *alutaceus*) that I had at first imagined them actually to belong to the same genus; but a more careful inspection will show that they have certain peculiarities which, although insignificant perhaps in other families, are of primary importance amongst the *Anthribidæ*, and which necessitate the establishment of a special group for their reception. Thus, they have no appearance whatsoever of a transverse line either before or *at* the extreme base of their prothorax (a structure of peculiar significance in the Anthribids); their antennæ also are implanted distinctly further from the eyes than is the case in *Notioxenus* (where the scrobs absolutely adjoins the anterior margin); and the first joint of their two hinder feet is less elongated. In their more or less faintly metallic, sparingly pubescent, and sculptured surfaces they have much the appearance of minute *Notioxeni*.

57. *Homœodera rotundipennis*, n. sp.

H. subovata, nigra, in elytris subænescens, pube grossa demissa fulvescente parce nebulosa; capite prothoraceque subrugose striguloso-(vel etiam subreticulato-) alutaceis sed vix punctatis, opacis; elytris subrotundatis basi truncatis sed pone medium paulo latioribus, obsolete subæneo-micantibus, grosse et profunde striato-punctatis, punctis magnis, interstitiis rugosis et subcostatoelevatis, ante apicem obsolete subfasciatis; antennis pedibusque nigro-piceis, illis ad basin rufo-ferrugineis.

Long. corp. lin. $1\frac{1}{3}$.

The apparently somewhat larger size (judging from the single example now before me) of this little *Homœodera*, added to its slightly darker and more opaque and roughened head and prothorax (which seem to be free from even an obscure brassy tinge, and are rather more sub*strigulose* perhaps, or even granulous, than punctate), its more rounded and coarsely sculptured elytra (the punctures and striæ of which are exceedingly large, with the interstices roughened and elevated, or subcostate), and its appreciably blacker limbs, will sufficiently distinguish it from both of the following species. The example from which my diagnosis has been drawn out was taken in St. Helena by Mr. Melliss.

58. *Homœodera alutaceicollis*, n. sp.

H. suboblonga, subæneo-nigra, pube grossa demissa fulvescente parce nebulosa; capite prothoraceque argute, regulariter, et obtuse alutaceis (necnon, oculo fortissime armato, punctis levissimis obsoletis remotis parcissime irroratis), subopacis; elytris ovalibus, nitidioribus, argute striato-punctatis, ante apicem plerumque obsolete subfasciatis; antennis pedibusque aut piceis aut testaceo-piceis, illis ad basin rufo-ferrugineis, articulis intermediis sensim brevioribus.

Long. corp. lin. $1–1\frac{1}{3}$.

The present species and the following one are rather more oblong than the *H. rotundipennis*, their elytra being *relatively* a trifle longer and less rounded; but in point of mere size (although apparently there is not much difference between them) they would seem to follow each other in a regular sequence. In other respects the *H. alutaceicollis* may be known by its head and prothorax being conspicuously (but *not* roughly) alutaceous, which makes the surface subopaque without being at all roughened, and gives to it, when viewed beneath the microscope, the texture somewhat of seal-skin; and by its elytra being sharply striate-punctate, but rather less coarsely (and roughly) so than is the case in either of its allies. Several examples of it are amongst the St.-Helena collection of Mr. Melliss.

59. *Homœodera pygmæa*, n. sp.

H. suboblonga, subæneo- vel subviridi-nigra, parum nitida, pube grossa demissa fulvescente parce nebulosa; capite prothoraceque rugulose alutaceis punctisque magnis sed vix profundis dense obsitis; elytris ovalibus, rugose punctato-striatis, interstitiis rugosis ac parum elevatis, ante apicem plerumque obsolete subfasciatis; antennis pedibusque fere ut in specie præcedente.

Long. corp. lin. $\frac{3}{4}$–1.

The few examples which I have yet seen of this *Homœodera* were, like those of the last, collected by Mr. Melliss. It is apparently a trifle smaller, on the average, than the *H. alutaceicollis*, to which, however, in its somewhat oblong outline and general *facies* it is closely allied. It may nevertheless be recognized from *both* of the preceding species by its head and prothorax being a little less opaque (or nearly as shining as the elytra), and densely studded with large but not particularly deep punctures. Its elytral sculpture is appreciably coarser and rougher than that of *alutaceicollis*, but not so coarse as in *rotundipennis*.

Fam. 20. **Bruchidæ.**

Genus 38. Bruchus.

Geoffroy, Ins. de Paris, i. 163 (1762).

60. *Bruchus rufo-brunneus*, n. sp.?

B. subquadrato-ovatus, rufo-brunneus, elytris clarioribus, subtus dense cinereo, supra inæqualiter fulvescente et cinereo piloso-variegatus, antennis pedibusque piceo-testaceis, illis versus apicem (saltem in sexu masculo) pedibusque posticis paulo obscurioribus; capite prothoraceque conico dense ruguloso-punctatis, illo fortiter carinato, hoc in parte media basali macula subquadrata subbipartita cinerea notato; elytris profunde striatis, interstitiis rugulosis convexis, fasciis 3 obsoletissimis nigrescentibus (interdum cinereo terminatis) intus valde abbreviatis sæpius obscure nebuloso ornatis; femoribus posticis denticulis duobus contiguis (e marginibus externo et interno surgentibus) subtus armatis, tibiis posticis ad angulos apicales internos spinis duabus inæqualibus (una sc., præsertim in sexu masculo, elongata robusta) terminatis.

Mas antennis multo longioribus, paulo crassioribus, ac intus longe pectinatis; pedibus anterioribus etiam subgracilioribus longioribusque.

Long. corp. lin. circa $1\frac{1}{2}$.

It is with the greatest reluctance that I venture to describe as new several examples of a *Bruchus* which are now before me, and which were captured by Mr. Melliss at St. Helena, because such a vast majority of the *Bruchi* hitherto known are so peculiarly liable to accidental importation throughout the civilized world, along with various seeds and fruits, that I cannot but feel it probable that the one now under consideration may have been found in or about the houses and stores, and may be well known (and perhaps even recorded) for some other tropical country. Yet, as I have been unable to identify it with any of the numerous species to which I have had access, I think it better to run the risk of its having been already described than to omit it altogether from the present catalogue.

The main features of this *Bruchus* seem to consist in its reddish-brown hue, the elytra, however, being more pale and rufescent than the head and prothorax; in the latter being dappled with cinereous scales, which are concentrated into a squarish central bipartite patch in the middle (behind the scutellum), and sometimes apparently into two obsolete and fragmentary (or broken-up) oblique bands; in its head being powerfully keeled; in its elytra being deeply striate (with the interstices convex), and likewise ornamented (in unrubbed specimens) with rudimentary bands or fasciæ, on either side, composed, in examples which are highly coloured, of darkish cloudy patches with a few ashy scales between; in the antennæ of the male being very much longer than those of the female, and deeply pectinated internally; and in its two posterior femora being armed beneath with two small denticles, alongside each other and arising out of the inner and outer edges respectively—whilst the two inner angles of its two hinder tibiæ are each terminated by a spine, one of which (particularly in the male sex) is robust and elongated.

61. *Bruchus advena*, n. sp.?

B. fere ut species præcedens, sed paulo angustior ac sensim magis ellipticus (pygidio minus perpendiculari), capite minus evidenter carinato, prothorace sensim profundius punctato, elytris clarius rufescentibus lætiusque pictis, multo magis tenuiter leviusque subcrenulato-striatis, interstitiis valde depressis (nec convexis), antennis brevioribus, femoribusque posticis omnino simplicibus (nec subtus denticulatis) et spinis terminalibus minus robustis.

Long. corp. lin. $1\frac{1}{2}$.

Although with much the same colouring, and *primâ facie* aspect, as the last species, it is quite impossible to identify with it the single example from which the above diagnosis has been drawn out—though I feel it extremely likely that both of them are natives of the same country (wheresoever that may be), and may perhaps have become naturalized, through the medium of commerce, in the stores and granaries of St. Helena. The specimen before me (which was captured by Mr. Melliss) appears to be a female one, so that I am unable to decide whether there are any particular features (of antennæ &c.) to distinguish the opposite sex; but, judging from this individual, the species is a trifle narrower and more elliptic than the *B. rufobrunneus* (its pygidium being less perpendicularly decurved), with its head less evidently keeled, its antennæ shorter and more compact, its prothorax rather more deeply punctured, and with its elytra not only of a redder tint and more conspicuously marked, but also very much more finely and lightly striated, and considerably flatter in the interstices. The terminal spines of its two hinder tibiæ also are less developed, and its hinder femora are entirely free from all traces of the two small denticles which characterize its ally.

Fam. 21. **Halticidæ.**

Genus 39. Longitarsus.

Latreille, Fam. Nat. 405 (1825).

62. *Longitarsus Helenæ.*

L. oblongo-ovatus, æneo-viridis, subnitidus, alutaceus; capite impunctato; prothorace punctulis levibus minutis parce irrorato, ante medium latiusculo, postice paulo angustiore, angulis posticis obtusis; elytris profundius punctatis; antennis pedibusque longissimis, rufo-testaceis, illis versus apicem femoribusque posticis vix obscurioribus.

Mas [an quoque fœm.?] tarsis anterioribus art^{o} 1mo magno, valde dilatato.

Long. corp. lin. 1.

Longitarsus Helenæ, Woll., Journ. of Ent. i. 214 (1861).

A single example of this distinct *Longitarsus* was taken in St. Helena by Mr. Bewicke, in 1860; and two more have lately been communicated by Mr. Melliss. It may easily be known by its alutaceous surface and brassy-green hue, by its pale elongated limbs, and by the largely developed joint of the four anterior feet of the male. Its head appears to be quite unpunctured, and its prothorax sparingly sprinkled with punctules which are extremely minute, whilst its elytra are rather strongly punctate*.

* Whether any *Cryptocephalus* or *Clythra* occurs in St. Helena I cannot say; but I may call attention, in this part of my catalogue, to the *Cryptocephalus ruficollis* of Fabricius, which was originally described by him (Syst. Ent. 109) in 1775 from a St.-Helena specimen (or specimens) in the collection of Sir Joseph Banks. Judging from his own publications, he seems to have fallen into some unaccountable mistake (or even misrepresentation) regarding this species, which he had himself first defined, and ultimately to have shifted his diagnosis to a Mediterranean insect which in all probability is totally distinct from the St.-Helena one; for, in 1792 (*vide* Ent. Syst. i. ii. 61), he *added* to his original description, and gave as the *habitat* not only St. Helena, but (on the authority of Prof. Helwig) Italy!! In 1798 (*vide* Suppl. 114, of the Ent. Syst.) he appears

Fam. 22. **Cassididæ.**

Genus 40. ASPIDOMORPHA.

Hope, Col. Man. (1840).

63. *Aspidomorpha miliaris.*

A. "flava, thorace immaculato, elytris nigro punctatis: margine bifasciato. Habitat in ins. St. Helenæ. *Mus. Dom. Banks.* Statura *C. marginatæ.* Antennæ flavæ, apice nigræ. Thoracis clypeus rotundatus, integer, immaculatus. Elytra lævia, flava, punctis circiter 10 nigris sparsis. Margo uti in reliquis dilatatus fasciis duabus, altera ad basin, altera versus apicem, nigris. Sutura apice nigra. Subtus nigra, margine flavescente. Pedes flavi." [Ex *Fabricio.*]

Cassida miliaris, Fab., Syst. Ent. 91 (1775).
—— ——, Oliv., Encycl. Méth. v. 385 (1791).
—— ——, Id., Ent. vi. 943. 33, t. 2. f. 25 (1808).
—— ——, Fab., Ent. Syst. i. 300 (1792).
—— ——, Id., Syst. Eleuth. i. 400 (1801).
Aspidomorpha miliaris?, Bohem., Mon. Cass. ii. 261 (1854).

I know nothing of the present insect beyond the mere fact of the above quotation from Fabricius; but as the species is stated plainly to have come from St. Helena, and to be in the Banksian collection, I can see no reason for doubting its *habitat*, particularly since other Coleoptera belonging to the late Sir Joseph Banks were unquestionably (as in the case of the *Cydonia lunata*) received from the same island. I therefore conclude that there is some member of the *Cassididæ* to be

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to have discovered that the insect was a *Clythra,* and cited it accordingly, though whether this conclusion was arrived at after a re-examination of the original St.-Helena example, or merely of those from southern Europe, it is impossible now to tell; but in any case it is quite clear that his first description applied to the St.-Helena one, and not to that from Italy. Having thus, however, altered his diagnosis so as to make it tally with the Italian species, he appears to have lost sight of the original St.-Helena type altogether; for in the Syst. Eleuth. (ii. 38) he still *refers to* his former volumes, but records southern Europe as the *only habitat* for his "*Clythra ruficollis,*" omitting even a passing *allusion* to St. Helena!! After this admission of his own, it is not surprising that European naturalists should have accepted, on his authority, the name of *ruficollis* (although applied at first to a St.-Helena species) for the Mediterranean insect; and accordingly every subsequent writer, including even Lacordaire (Mon. des Phytoph. ii. 100), has so done; and yet it seems to me to be more than doubtful whether the well-known *Clythra* (or *Macrolenes*) *ruficollis* of southern Europe *is* in reality identical with Fabricius's original "*Cryptocephalus ruficollis*" (despite his own subsequent representation) from St. Helena. If it should prove ultimately that the two are different, it follows of necessity that the title "*ruficollis*" (whatsoever the *genus* may be) will have to apply to the insect from that island, and that the European one must receive a new name.

found in St. Helena, answering to the Fabrician diagnosis, which has escaped detection in more recent times; and my reason for regarding it as an *Aspidomorpha* (a genus which occurs in western Africa and the Cape-Verde archipelago) is simply because Boheman, in his Monograph of the family, cites the *Cassida miliaris* of Fabricius as a member of that particular genus. Yet, on the other hand, Boheman does *not* acknowledge the species which he has identified with the Fabrician one as a native of St. Helena at all, but, rather, of the East Indies, Java, Celebes, China, and the Philippine Islands, which at once raises a geographical difficulty which it is not easy to solve. But, as there appears no cause (in the absence of any kind of explanation by Boheman) for assuming the originally asserted *habitat*, of Fabricius, to be incorrect, I prefer the contrary conclusion, and should be inclined to think that Boheman may himself have been mistaken in identifying a *Cassida* of Eastern Asia with one (*perhaps* closely allied) from St. Helena. At any rate, as I have no evidence (beyond the tacit assumption of Boheman) that Fabricius and Sir Joseph Banks were alike in error concerning the country from which the original *C. miliaris* was received, I have no choice but to include the species in the present memoir.

Fam. 23. **Coccinellidæ.**

Genus 41. Cydonia.

Mulsant, Sécurip. 430 (1851).

64. *Cydonia lunata.*

Coccinella lunata, Fab., Syst. Ent. 86 (1775).
—— ——, Id., Syst. Eleuth. i. 384 (1801).
Cydonia lunata, Muls., Sécurip. 431 (1851).
—— ——, Woll., Journ. of Ent. i. 214 (1861).

This curiously and prettily marked Coccinellid appears to be common in St. Helena, where it has been taken abundantly by Mr. Melliss and previously also by Mr. Bewicke and others. Indeed, although with a wide geographical range (it having been recorded from Senegal, the Cape of Good Hope, Caffraria, Madagascar, the islands of Bourbon and Mauritius, the East Indies and Java), it was originally described by Fabricius (in 1775) from St.-Helena specimens, now in the Banksian collection; and therefore, whatever doubt may be entertained as to the claim for specific separation of some of the extreme states which have been ascribed to it, there can at least be no question about the St.-Helena form, which must of necessity be looked upon as the typical one.

Genus 42. EPILACHNA.

Chevrolat, Dict. Univ. d'Hist. Nat. iv. 43 (1844).

65. *Epilachna chrysomelina.*

E. "coleopteris rufis: punctis duodecim nigris, thorace immaculato. Habitat in ins. St. Helenæ. *Mus. Dom. Banks.* Major. Caput et thorax rubra, immaculata, margine paullo pallidiora. Elytra rufa, punctis sex nigris per paria distributis. Pedes flavescentes." [Ex *Fabricio.*]

Coccinella chrysomelina, Fab., Syst. Ent. 82 (1775).
—— *capensis*, Thunb., Nov. Ins. Spec. i. 16, tab. 1. f. 21 (1781).
—— *chrysomelina*, Fab., Ent. Syst. i. 278 (1792).
—— ——, Id., Syst. Eleuth. i. 368 (1801).
Epilachna chrysomelina, Muls., Sécurip. 793 (1851).

Although I have never seen a St.-Helena example of the Mediterranean *E. chrysomelina*, I can scarcely refuse it a place in the present memoir, inasmuch as it was originally described by Fabricius, in 1775 [*vide* the above diagnosis], from an example, or examples, in the collection of Sir Joseph Banks, which had been obtained in that island. Indeed, as it appears to occur also at the Cape of Good Hope, and Fabricius himself in 1792 cites as its *habitat* "in Cacto opuntio Africæ," there is no reason for doubting that the Banksian type was truly (as stated) a St.-Helena one, though it is of course highly probable that the species may have been introduced accidentally into the island, perhaps along with plants of the *Cactus opuntia* (or "prickly pear"), and so have become naturalized. It is recorded likewise in the north of Africa; but it has not yet been observed in any of the Atlantic archipelagos.

Fam. 24. **Opatridæ.**

Genus 43. OPATRUM.

Fabricius, Syst. Ent. 76 (1775).

66. *Opatrum hadroides.*

O. oblongum, latiusculum, nigrum, opacum, ubique granulato-rugulosum, breviter fulvescenti-pubescens; capite lato, ad latera ante oculos subrotundato-ampliato; prothorace brevi, ad latera subæqualiter leviter rotundato, angulis anticis acutiusculis, posticis acutis sed haud longe productis; elytris parallelis (ad humeros rectangulis), subpunctato-striatis, interstitiis subconvexis.
Long. corp. lin. $3\frac{1}{2}$–5.

Opatrum hadroides, Woll., Journ. of Ent. i. 215 (1861).

The present *Opatrum*, like most of the allied species in the various Atlantic archipelagos, appears to abound in St. Helena, where it was taken by the late Mr. Bewicke in 1860, and where, according to Mr. Melliss, it is often peculiarly gregarious in cultivated spots, especially the potato-grounds. When publishing my diagnosis of it in 1861, I stated that "although unwilling to erect a new species in such an extensive and obscure genus as *Opatrum*, yet, after a careful comparison of the insect under consideration with a long series of Atlantic forms (from Madeira, the Canaries, the Cape Verdes, and the Cape of Good Hope), I am induced to do so in this instance, since the remoteness of its island *habitat* renders it probable that it will be found to be peculiar to St. Helena. The whole of the winged *Opatra* (*i. e.* the *Gonocephala* of Solier) are moulded so nearly on the same type, that small differences which might be disregarded in many groups become important with them; and, after a close examination, I am convinced that there are no characters so much to be depended upon as the exact form of the *genæ*, or dilated sides of the head immediately in front of the eyes, and the relative depth of the emargination (involving the greater or less acuteness of the anterior angles) of the prothorax. The *O. hadroides* is very nearly akin to a species which was taken by Mr. Bewicke at the Cape of Good Hope; but it is altogether rather larger, broader, and more parallel, its head is a little wider, with the *genæ* more rounded, its prothorax is less deeply scooped-out in front, with the anterior angles consequently less porrect and more obtuse, the hinder angles also are somewhat less produced, and its shoulders are more rectangular. Although narrower and on a smaller scale, it has a slight *primâ facie* resemblance, in general contour, to the more parallel-sided *Hadri* of the Madeiran group—a circumstance which has suggested its trivial name."

Fam. 25. **Ulomidæ.**

Genus 44. Alphitobius.

Stephens, Ill. Brit. Ent. v. 11 (1832).

67. *Alphitobius diaperinus**.

Tenebrio diaperinus, Kugel., in Pnz. Fna Ins. Germ. 37. 16 (1797).
Alphitobius diaperinus, Woll., Col. Atl. 419 (1865).
—— ——, Id., Col. Hesp. 208 (1867).

Judging from the specimens which were taken by Mr. Melliss, the widely spread *A. diaperinus* has become established in St. Helena, as is the case with it in the Madeiras, Canaries, Cape-Verdes, and Ascension, and indeed throughout the greater portion of the civilized world; but I need scarcely add that it is no more connected, in reality, with our present fauna than it is with that of any other country where it has in like manner been introduced through the medium of commerce.

68. *Alphitobius piceus**.

Tenebrio mauritanicus, Fab. [nec L., 1767], Ent. Syst. i. 113 (1792).
Helops piceus, Oliv., Ent. iii. 58. 17. 22 (1795).
Tenebrio fagi, Pnz., Fna Ins. Germ. 61. 3 (1799).
Alphitobius piceus, Woll., Col. Atl. 419 (1865).
—— ——, Id., Col. Hesp. 208 (1867).

Likewise obtained by Mr. Melliss in St. Helena, but, of course (as in the case of the preceding species), naturalized through the medium of commerce. It has been established equally in the Azores, Madeiras, Canaries, Cape-Verdes, and in Ascension, in which last-mentioned island it was found, in company with the *A. diaperinus*, by the late Mr. Bewicke, *not* in houses and amongst farinaceous substances, as we should have expected, but "in the dung of sea-birds, *miles from habitable parts*," which is undoubtedly a singular habit for these common and almost cosmopolitan insects to have acquired.

A. piceus may be known from *diaperinus* by being a trifle narrower and less shining, by its prothorax being relatively a little broader, rounder (and more margined) at the sides, somewhat more thickly punctured, and with the hinder angles more acute, by the punctures of its elytral interstices being larger and more numerous, and by its tibiæ being appreciably less widened, and almost free from (even minute) spinules. Moreover it scarcely attains quite so large a stature as its ally.

Genus 45. Gnathocerus.

Thunberg, Act. Holmiens. 47 (1814).

69. *Gnathocerus cornutus**.

Trogosita cornuta, Fab., Ent. Syst. (Suppl.) 51 (1798).
Cerandria cornuta, Woll., Ins. Mad. 490 (1854).
Gnathocerus cornutus, Id., Col. Atl. 420 (1865).
—— ——, Id., Col. Hesp. 204 (1867).

Like the last two species, and the two which follow, the almost cosmopolitan *G. cornutus* has (judging from examples now before me, which were captured by Mr. Melliss) become established in St. Helena, where, no doubt, it must occur, amongst farinaceous and other substances, in and about the houses and stores. It has in like manner been introduced (of course through the medium of commerce) in the Madeiras, Canaries, Cape-Verdes, and Ascension.

Genus 46. TRIBOLIUM.

MacLeay, Annul. Javan. 47 (1825).

70. *Tribolium ferrugineum**.

Tenebrio ferrugineus, Fab., Spec. Ins. i. 324 (1781).
Tribolium ferrugineum, Woll., Col. Atl. 420 (1865).
—— ——, Id., Col. Hesp. 204 (1867).

There is hardly any Coleopterous insect more liable to accidental introduction, along with numerous articles of food and commerce, into the various countries of the civilized world than the present one; and it is not surprising, therefore, that it should have been found by Mr. Melliss, together with other species of similar habits, in St. Helena. It has become established, in like manner, in the Azorean, Madeiran, Canarian, and Cape-Verde archipelagos.

Fam. 26. **Tenebrionidæ.**

Genus 47. TENEBRIO.

Linnæus, Syst. Nat. edit. 6 (1748).

71. *Tenebrio obscurus**.

Tenebrio obscurus, Fab., Ent. Syst. i. 111 (1792).
—— ——, Woll., Col. Atl. 424 (1865).

The common *Tenebrio obscurus* has become naturalized in the houses and granaries of St. Helena, where it was taken abundantly by Mr. Melliss. It would seem to have acquired a more southern range, on the whole, than *T. molitor*; for while it has been established almost universally throughout the Azorean, Madeiran, and Canarian archipelagos, *T. molitor*, on the contrary, I have never yet fallen in with in any of them—two examples, which were captured in Madeira, many years ago, by the late Dr. Heineken, supplying the only instance, so far as I am aware, of its occurrence in the Atlantic groups.

Genus 48. ZOPHOBAS.

(Dejean) Blanch., Hist. Nat. des Ins. ii. 15 (1840).

72. *Zophobas concolor*, n. sp.

Z. subparallelo-elongatus, niger (concolor), subnitidus sed interdum hinc inde quasi nebuloso-subopacus, calvus, alatus; capite antico parce sed postice etiam parcius grossiusque punctato, utrinque intra angulos frontales foveola minuta impresso; prothorace transverso-subquadrato, antice paulo latiore et leviter rotundato, angulis anticis rotundate obtusis, posticis subproducte acutiusculis, sensim marginato, convexo, in disco punctis magnis remotis parcissime irrorato, postice in medio transversim impresso, necnon utrinque ad basin ipsissimam foveola parva brevi notato; elytris prothorace paulo latioribus, postice regulariter leniterque attenuatis, grosse punctato-sulcatis; antennis pedibusque longiusculis, in utroque sexu similibus æqualibus.

Mas, vix minor, clypeo antice profunde arcuato-emarginato, tibiis anticis intus omnino calvis, posterioribus versus apicem paululum fulvo-pubescentibus.

Fœm., vix major, clypeo antice recte truncato, tibiis intus versus apicem (præsertim anticis) breviter fulvo-pubescentibus.

Long. corp. lin. $9\frac{1}{2}$–10.

Judging from the very short and imperfect "diagnosis" (so called) of Fabricius, this large and uniformly black Tenebrionid might possibly agree with his *Helops morio* from the West Indies and other parts of Equatorial America; but I think that its sexual peculiarities do not tally with what little I can gather elsewhere about those of that species; for there seems to be no difference in the relative length of the limbs, and curvature of the tibiæ, between the males and females of the insect from St. Helena. Yet, as in some of the other recorded members of this singular group, there is the strange dissimilarity in the form of the clypeus (which is straightly truncate in the females, but deeply scooped-out in the opposite sex), as well as the perfect freedom from hairs of the front male tibiæ, whilst the female ones are (like the four hinder ones of that sex) furnished internally, towards their apex, with a short fulvescent pile. Were it not for the greater length of its limbs (particularly the antennæ), the present insect, in its comparatively narrow elongated outline, and general contour, would have much the *primâ facie* aspect of a large *Tenebrio*; and it may be further recognized by its deep-black surface being somewhat dulled, or clouded, in parts (especially towards the sides and behind), as though by a kind of *bloom*, by its prothorax being simply besprinkled on the disk with a few large and remote punctures, and by its elytra (which are gradually attenuated towards the apex) being regularly and coarsely punctate-sulcate. Its head is branded with a little foveolet on either side in front, just within the angle of the clypeus; and its prothorax (which is transversely impressed across the greater portion of its base) has a somewhat similar one, and almost equally minute, adjoining the extreme margin, at either end of the transverse impression.

The two examples from which the above diagnosis has been compiled were taken in St. Helena by Mr. Melliss; but whether the species has been naturalized accidentally from America, and occurs only about the houses and cultivated spots, or whether it may have all the appearance *in situ* of being truly indigenous, my ignorance of the circumstances under which the specimens were captured forbids me to conjecture.

Fam. 27. **Mordellidæ.**

Genus 49. Mordella.

Linnæus, Syst. Nat. edit. i. 420 (1758).

73. *Mordella Mellissiana*, n. sp.

M. angusto-elliptica, supra arcuata, rufo-brunnea (rarius nigro-brunnea) et pube fulvescente valde demissa dense sericata; capite subsemicirculari, deflexo, oculis magnis; prothorace subconico, basi bisinuato; scutello minuto; elytris regulariter versus apicem attenuatis, apice singulatim rotundatis, haud striatis; pygidio in mucronem elongatum producto; antennis pedibusque anterioribus paulo clarioribus.

Long. corp. lin. 2–3.

The uniformly reddish-brown surface of this rather large *Mordella*, which is densely clothed with a very decumbent, yellowish, or fulvescent silken pubescence, must serve to distinguish it. The strong mucro into which its pygidium is produced, although merely a generic character, will additionally separate it from everything else with which we have to do in the St.-Helena catalogue. The few examples which have come under my notice were captured by Mr. Melliss, after whom it gives me much pleasure to name the species.

Fam. 28. **Staphylinidæ.**

Genus 50. Creophilus.

(Kirby) Steph., Ill. Brit. Ent. v. 202 (1832).

74. *Creophilus maxillosus**.

Staphylinus maxillosus, Linn., Syst. Nat. 421 ((1758).
—— ——, Woll., Cat. Mad. Col. 188 (1857).
Creophilus maxillosus, Id., Col. Atl. 487 (1865).

A single example of the common European *C. maxillosus* is amongst Mr. Melliss's *collectanea* from St. Helena; and there cannot be the slightest doubt, therefore, that the species has been naturalized in the island from more northern latitudes. It has in like manner become established in the Azores, Madeiras, and Canaries.

CATALOGUS SYSTEMATICUS.

CARABIDÆ.

1. *Haplothorax*, Waterh.
   1. Burchellii, *Waterh.*
2. *Calosoma*, Weber.
   2. haligena, *W.*
   3. Helenæ, *Hope.*
3. *Pristonychus*, Dej.
   4. complanatus, *Dej.*
4. *Bembidium*, auct.
   5. Mellissii, *W.*

SPHÆRIDIADÆ.

5. *Dactylosternum*, W.
   6. abdominale, *Fab.*
6. *Sphæridium*, Fab.
   7. dytiscoides, *Fab.*

CUCUJIDÆ.

7. *Læmophlœus*, (Dej.) Erichs.
   *8. pusillus, *Schön.*
8. *Cryptamorpha*, W.
   9. musæ, *W.*

CRYPTOPHAGIDÆ.

9. *Cryptophagus*, Hbst.
   *10. affinis, *St.*

MYCETOPHAGIDÆ.

10. *Mycetæa*, (Kby.) Steph.
    *11. hirta, *Gyll.*
11. *Typhæa*, (Kby.) Steph.
    *12. fumata, *Linn.*

DERMESTIDÆ.

12. *Dermestes*, Linn.
    *13. cadaverinus, *Fab.*
    *14. vulpinus, *Fab.*
13. *Attagenus*, Lat.
    *15. gloriosæ, *Fab.*

HISTERIDÆ.

14. *Tribalus*, Erichs.
    16. 4-striatus, *W.*
15. *Saprinus*, Erichs.
    17. lautus, *W.*

APHODIADÆ.

16. *Aphodius*, Illig.
    *18. lividus, *Oliv.*

RUTELIDÆ.

17. *Adoretus*, (Eschsch.) Castln.
    19. versutus, *Harold.*

DYNASTIDÆ.

18. *Heteronychus*, (Dej.) Burm.
    20. arator, *Fab.*
19. *Melissius*, (Bates) W.
    21. eudoxus (*Dej.*), *W.*
    22. adumbratus, *W.*

ELATERIDÆ.

20. *Heteroderes*, Lat.
    23. puncticollis, *W.*

CLERIDÆ.

21. *Corynetes*, Hbst.
    *24. rufipes, *Thunb.*

PTINIDÆ.

22. *Gibbium*, Scop.
    *25. scotias, *Fab.*

ANOBIADÆ.

23. *Anobium*, Fab.
    *26. velatum, *W.*
    *27. paniceum, *Linn.*
    *28. striatum, *Oliv.*
    *29. confertum, *W.*

BOSTRICHIDÆ.

24. *Rhizopertha*, Steph.
    *30. bifoveolata, *W.*
    *31. pusilla, *Fab.*

TOMICIDÆ.

25. *Tomicus*, Lat.
    32. æmulus, *W.*

HYLESINIDÆ.

26. *Hylurgus*, Lat.
    *33. ligniperda, *Fab.*

CURCULIONIDÆ.
(Cossonides.)

27. *Stenoscelis*, W.
    34. hylastoides, *W.*
28. *Microxylobius*, Chevr.
    35. Westwoodii, *Chevr.*
    36. vestitus, *W.*
    37. lacertosus, *W.*
    38. lucifugus, *W.*
    39. terebrans, *W.*
    40. obliteratus, *W.*
    41. debilis, *W.*
    42. Chevrolatii, *W.*
    43. conicollis, *W.*
    44. monilicornis, *W.*

29. *Pentarthrum*, W.
 45. subcæcum, *W.*
(Rhynchophorides.)
30. *Sitophilus*, Schönh.
 46. oryzæ, *Linn.*
(Synaptonychides.)
31. *Nesiotes*, W.
 47. squamosus, *W.*
 48. asperatus, *W.*
(Trachyphlœides.)
32. *Trachyphlœosoma*, W.
 49. setosum, *W.*
(Otiorhynchides.)
33. *Sciobius*, Schönh.
 50. subnodosus, *W.*
34. *Otiorhynchus*, Germ.
 *51. sulcatus, *Fab.*

ANTHRIBIDÆ.

35. *Aræocerus*, Schönh.
 *52. fasciculatus, *De Geer.*
36. *Notioxenus*, W.
 *53. Bewickii, *W.*
 54. rufopictus, *W.*
 55. dimidiatus, *W.*
 56. alutaceus, *W.*
37. *Homœodera*, W.
 57. rotundipennis, *W.*
 58. alutaceicollis, *W.*
 59. pygmæa, *W.*

BRUCHIDÆ.

38. *Bruchus*, Geoffr.
 60. rufobrunneus, *W.*
 61. advena, *W.*

HALTICIDÆ.

39. *Longitarsus*, Lat.
 62. Helenæ, *W.*

CASSIDIDÆ.

40. *Aspidomorpha*, Hope.
 63. miliaris, *Fab.*

COCCINELLIDÆ.

41. *Cydonia*, Muls.
 64. lunata, *Fab.*
42. *Epilachna*, Chevr.
 65. chrysomelina, *Fab.*

OPATRIDÆ.

43. *Opatrum*, Fab.
 66. hadroides, *W.*

ULOMIDÆ.

44. *Alphitobius*, Steph.
 *67. diaperinus, *Kugel.*
 *68. piceus, *Oliv.*
45. *Gnathocerus*, Thunb.
 *69. cornutus, *Fab.*
46. *Tribolium*, MacLeay.
 *70. ferrugineum, *Fab.*

TENEBRIONIDÆ.

47. *Tenebrio*, Linn.
 *71. obscurus, *Fab.*
48. *Zophobas*, (Dej.) Blanch.
 72. concolor, *W.*

MORDELLIDÆ.

49. *Mordella*, Linn.
 73. Mellissiana, *W.*

STAPHYLINIDÆ.

50. *Creophilus*, (Kby.) Steph.
 *74. maxillosus, *Linn.*

V.—*Notulæ Lichenologicæ.* No. XXXI.

By the Rev. W. A. LEIGHTON, B.A., F.L.S., F.B.S. Ed.

On certain new Characters in the Species of the Genera Nephroma (*Ach.*) *and* Nephromium, *Nyl.*

EVERY student of the Lichenes, who examines his specimens with close observation, must frequently have noticed many characters which are not included in the diagnoses of species generally given by writers. These characters, which may be termed secondary, are usually minute and easily overlooked. Nevertheless where they are found to be constant, they prove to be important and characteristic, and of a useful value in recognizing and determining the species or varieties in which they occur. More especially are they serviceable in those genera in which the spores, from their general similarity, are only partially available. In the preparation of my 'Lichen-Flora of Great Britain,' now drawing towards completion, these secondary characters have been frequently noticed in many genera; and I have accordingly pressed them into service. By accident my attention has been very recently drawn to the genera *Nephroma* and *Nephromium*, the species of which have been hitherto involved in very considerable confusion, especially those of the latter genus, by reason of the several species and varieties being frequently found growing in the same locality, and often in intermixture.

The new characters which I have detected here are the chemical reaction of the thallus, the colour of the medullary stratum and its chemical reaction, and the structure of the back of the receptacle of the apothecia. Having gone through the goodly store of specimens in my own herbarium with satisfactory results, I was naturally anxious to extend my researches through the Hookerian Herbarium at Kew. Dr. Hooker, with that generous liberality so characteristic both of himself and of his father, the lamented Sir W. J. Hooker, ever ready and desirous to aid and promote scientific inquiry, at once opened these collections to me. The examination has enabled me to effect a double service—to test and establish the certainty and constancy of these characters, and to rearrange in a more complete manner these genera in that herbarium.

The genus *Nephroma* is distinguished by the gonidial stratum being of a pale yellow-green colour and composed of simple gonidia; whilst *Nephromium* has that layer of a dark blue or verdigris-green, and composed of granular gonima. The thallus in *Nephroma* is, moreover, by reason of its pale ochroleucous colour, capable of exhibiting certain chemical reactions with hydrate of potash and hypochlorite of lime, which serve also to separate it from *Nephromium*, in which the fuscescent or darker colour of the thallus renders any such reaction imperceptible. Practically, of course, it is of little real consequence whether we regard these as sections of one genus or as separate genera, so long as we can readily distinguish them by fixed characters. For readier comparison I have tabulated the characters to which I would call attention in the following way.

Nephroma (Ach.), Nyl.

Species.	Upper surface of thallus.	Under surface of thallus.	Margin of receptacle.	Back of receptacle.	Chemical reaction of thallus.	Colour of medulla.	Chemical reaction of medulla.	Localities and Remarks.
arcticum, Fr.	smooth and glabrous.	nigricanti-tomentose, rugulose immediately below apothecia.	protended, entire.	minutely depresso-granulate.	K—, C yellow.	white.	K—, C faint yellow.	North-west America! Norway! du Petit Nord à Terreneuve! Newfoundland! Arctic Regions! Kotzebue Sound! Rocky Mountains! Vancouver's Island! Upsal! Hungary!
antarcticum (Jacq.).	foveolate.	glabrous, white, and bullate, black in the centre.	much protended, laciniate.	impresso-rugose and minutely rimuloso-areolate.	K f.y, C y.	white.	K y, C y.	Chili! Arrigui forts, Chiloe! Staten Land! Straits of Magellan! Cape Horn! St. Martin's Cove, side of Mount Kater!
australe, A. Rich.	smooth and glabrous.	smooth and glabrous.	protended, irregularly laciniato-crenate.	minutely rimuloso-areolate.	K y, C y.	white.	K y, C y.	Tasmania! New Zealand! Island of Juan Fernandez!
schizocarpum, Nyl.	smooth.	glabrous.	....	....	....	white.	K —.	Of this species I have seen no specimen; but the fruit, divided like *Peltigera polydactyla*, affords an unmistakable character.
expallidum, Nyl.	smooth and glabrous below, tomentellose upwards.	tomentellose with pyrenoid cephalodia.	protended, undulato-crenate.	furfuraceo-depresso-granulate.	K y.	white.	K —.	East Lapland! Great Bear-Lake!

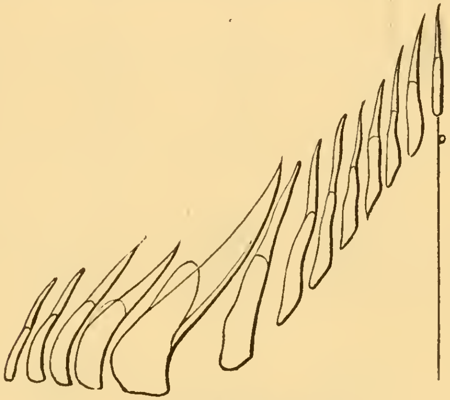
NEPHROMIUM, Nyl.

Species.	Upper surface of thallus.	Under surface of thallus.	Margin of receptacle.	Back of receptacle.	Colour of medulla.	Chemical reaction of medulla.	Localities and Remarks.
tomentosum, Hffm.	glabrous below, tomentose upwards.	pale and villose.	protended, annulari-tomentose, crenulate.	tomentose or villose.	white.	K—.	Switzerland! Vosges! North America! Mississippi river! South of France! Riesengebirge!
var. *rameum*, Schær.	glabrous below, tomentellose upwards.	villose, albido-papillate, pseudo-cyphellate.	protended, annulari-tomentose, crenulate.	rugulose, tomentose, or villose.	white.	K—.	Scotland! Vosges! British North America! Arctic Regions! River Winnipeg! Switzerland! Italy! Hungary! Sweden!
var. *helveticum* (Ach.).	glabrous below, tomentellose upwards.	villose.	protended, annulari-tomentose, dentato-fimbriate.	furfuraceo-depresso-granulate.	white.	K—.	Himalaya (11,000 feet)! Oregon! Arctic Regions! Vancouver's Island! Mississippi river! Italy! Germany! North America!
lævigatum, Ach.	glabrous.	glabrous, slightly rugulose.	crenulato-unequal.	minutely depresso-granulate.	white.	K—.	United States! Madeira! Hercynia! Italy!
var. *parile* (Ach.).	cæsio-sorediate.	glabrous.	....	....	white.	K—.	Vosges! Silesia! Hungary! France! Italy! Normandy!
var. *papyraceum* (Hffm.).	glabrous.	glabrous, tomentellose in the middle.	protended, undulato-crenate.	minutely depresso-areolate.	white.	K—.	Pyrenees! Switzerland! Cape of Good Hope! Vallesia!

var. *subtomentellum*, Nyl.	glabrous.	tomentellose.	crenulato-unequal.	minutely granulato-areolate.	white.	K yellowish.	East Lapland !
var. *rufum*, Bab.	glabrous.	tomentose.	dentato-fimbriate.	tomentellose.	white.	K—.	New Zealand !
sublævigatum, Nyl.	reticulato-rugose.	smooth, glabrous, fuscescent.	nearly entire.	. . . .	white.	K—.	Of this lichen I have seen no specimen.
lusitanicum, Schær.	smooth and glabrous.	glabrous, slightly rugulose.	crenato-laciniate, incurved.	minutely depresso-areolate.	yellow.	K red.	Canaries ! Java ! Switzerland ! Pyrenees ! Portugal ! Italy ! Scotland ! Cumberland ! Durham ! Yorkshire ! Shropshire ! Devonshire ! Cornwall ! North Wales ! Ireland !
plumbeum (Mnt.).	smooth and glabrous.	glabrous, tomentellose in the middle.	protended, irregularly crenate.	glabrous, impresso-rugulose.	white.	K—.	Chili ! Island of Juan Fernandez ! I cannot but consider this and *Lyallii* states of the same species. In *plumbeum* the spores are distinctly 3-septate, in *Lyallii* 1-septate, but the cells have a tendency to subdivide.
Lyallii (Bab.).	smooth and glabrous.	glabrous, slightly tomentellose in the middle.	protended, fimbriato-dentate.	glabrous, impresso-rugulose.	white.	K—.	New Zealand ! Middle Island !
cellulosum (Ach.).	reticulato-foveolate.	glabrous, white and bullate immediately below the apothecia.	protended, entire.	reticulato-foveolate.	white.	K—.	Van Diemen's Land ! Tasmania ! Staten Land ! Island of Juan Fernandez !

VI.—*On a new Genus of* Testacellidæ *in Australia.* By C. Semper.

It is a fact often complained of that it is extremely difficult or even impossible to obtain the animals of tropical shells, especially of the land-shells. This, indeed, is to be regretted the more, as even conchologists begin to understand that the examination of the animals will furnish many interesting observations, especially valuable for the geography of the species. Very lately I met with an instance which may be worth a short notice. Through the kindness of Herr v. Frauenfeld I obtained two well-preserved specimens of *Helix inæqualis*, Pfr., which, apparently, is common in Australia, the examination of which proved that I had a genuine Testacellid before me. The jaw is entirely wanting; and, as the drawing shows,



Rhytida inæqualis, Pfr.

the teeth of the tongue so completely resemble those of *Glandina* (of which genus I have had occasion to examine three species) that this Australian Helicean must necessarily be ranged close to *Glandina*.

In the work of Albers on the Helicidæ this species is placed in the group Rhytida, which is considered there the last subgenus of those allied to *Patula*. The type of the subgenus is *Helix Greenwoodi* of New Zealand, which is nearly related to the Australian species; however, *Helix Strangei*, Pfr., living also in Australia, comes nearer to it. The last species has lately been classified in the genus *Zonites* by Mousson (Journ. de Conch. ser. 3. vol. ix. p. 36); and indeed it cannot be gainsaid that both these flat *Rhytida*-species possess a certain *habitus* of *Zonites*; yet Crosse rightly remarks (*ibid.* p. 57. 1) that it is to be doubted if this species, the animal being unknown, is a genuine *Zonites*. If, indeed, all those species (to which, however, *Helix dictyodes*, Pfr., cannot possibly belong) ranged by Albers in his group of Rhytida really are the most nearly related to *inæqualis*, Pfr., which I examined, the whole group, under the name given by Albers, might be removed from the series of the *Helices* and placed among the Testacellidæ; however, I would caution against so summary a procedure, although convenient, and would rather encourage Australian and other malacologists not to shun the trouble of examining these animals, as, surely, through anatomical investigation the relations between the different groups of Pulmonata will be discovered more easily and sooner than by a continual accumulation of shells only. Certainly a conscientious comparison of shells will gradually lead to natural groups; but, in spite of immense collections, this conchological method will always be slow and at the same time dangerous, for the material available on this field is too easily monopolized. If, instead of the thousands of shells that annually are sent home by collecting travellers, only a few hundred species in spirits, allowing a more minute examination, were one day to reach Europe, such an event might well be hailed by malacozoology.

Würzburg, December 9, 1869.

VII.—*On a new Species of the Genus* Pennella. By Edward Perceval Wright, M.D., F.L.S., Professor of Botany in the University of Dublin.

[Plate I.]

The memoirs of Steenstrup and Lütken in the 'Transactions of the Danish Academy'*, and of Nordmann in the 'Bulletin of the Moscow Society of Naturalists'†, have added very largely to our knowledge not only of the species of the genus *Pennella*, but also of the great variation to which several of the species appear liable. The specific characters, however, are for the most part difficult to determine; this is fully recognized by Professor Claus in his memoir on the Lernæidæ ‡. This

* "Bidrag til Kundskab om det aabne Havs Snyltekrebs og Lernæer samt om nogle andre nye eller hidtil kun ufuldstændigt kjendte parasitiske Copepoder," Vidensk. Selsk. Skr. 5. R., Naturvidensk. og mathem. Afd. 5. Rd. 1861, pp. 341–432, tab. 1–15.

† "Neue Beiträge zur parasitischer Copepoden," Bull. Soc. Imp. des Naturalistes de Moscou, 1864, tom. xxxvii. pp. 461–520, Taf. 5–8.

‡ 'Beobachtungen über *Lernæocera*, *Peniculus* und *Lernæa*, ein Beitrag zur Naturgeschichte der Lernaeen,' Marburg & Leipsig, 4to, pp. 1–32, Taf. 1–4: 1868.

difficulty chiefly arises from the fact that all the organs of these strange, grotesque creatures are subject to such wondrous transformations. Such a division, for example, as that of Milne-Edwards * into those having a head with two horns and those having a head with three, disappears before such a species or variety as the *P. varians*, St. & L. † Heller, in the 'Novara-Reise' ‡, divides the family Lernæidæ into two groups or subfamilies, the second of which is distinguished by the females having filiform ovisacs: this section he calls Pennellinæ, subdividing it as follows:—

I. Those with a rostriform mouth, ovisacs long and not convoluted, bodies covered with a thin integument.
II. Those with a non-rostriform mouth, ovisacs convoluted, bodies covered with a hard integument.

The genera placed in the first division are:—*Pennella*, Oken; *Peniculus*, Nordmann; *Lernœonema*, M.-Edw.; and *Peroderma*, Heller.

Pennella sultana, Nord., is placed by Heller § in the second division, and forms a new genus, *Lernœolophus*, which, so far as regards the possession of abdominal plumose appendages, takes the place in this division that *Pennella* does in the first division.

While, therefore, fully aware of the difficulties that for the present surround this question of classification, and ready to admit that neither length of body nor size of cephalic, thoracic, or abdominal appendages can be looked on as certain indications of specific differences, I yet venture to bring forward as new the following species, in the belief that it is undescribed, and with the hope of throwing some little light on our knowledge of the genus. These parasites do not occur so very frequently as to lead me to hope that by waiting I might be able to decide the questions as to its range of variation &c. thoroughly.

Pennella orthagorisci, sp. n.

♀. *Cephalic region.* Twice as broad as long, divided into two lobes. On its dorsal surface, and situated between these lobes, an eye-spot; on either side of which, but scarcely in front, a pair of minute antennules with from thirteen to fifteen longish setæ on each; still further in front a pair of antennæ obscurely

* 'Histoire Naturelle des Crustacés,' tome iii. p. 522.
† *L. c.* p. 413.
‡ Zoologischer Theil, Bd. ii. Abth. 3. Crustaceen beschrieben von C. Heller. Wien, 1865, p. 244.
§ *L. c.* p. 251.

three-jointed, the distal joint cheliform. On the front of the head, on its ventral surface and surrounding the oral opening, are a number of small cauliflower-like excrescences, of which a few are more conspicuous than the others; sometimes these spring each from a separate base, sometimes two or more from the same twig. At the junction of the thoracic with the cephalic region there are two long horn-like appendages an inch and a half each in length; these arise from the dorsal surface, and, like the thoracic and abdominal regions, are invested by a thin, almost colourless integument, which forms a kind of tube around them.

Thoracic region. Applying this name to the region intervening between the horn-like appendages and the origin of the ovisacs, it is $5\frac{3}{4}$ inches in length: for the first three inches it is about an eighth of an inch in diameter; it then gradually expands until, where it joins the abdomen, it is fully a quarter of an inch in diameter; the integument forms a clear tube-like covering over it, and is quite smooth and glistening. Close to the head, on the ventral surface, are four pairs of minute appendages (feet), the first three pairs close together, the fourth and most anterior pair somewhat separated from the others: these very rudimentary feet, when highly magnified, appear to end in a minute claw.

Abdominal region. At the commencement of this region, and from its ventral surface, the two long ovisacs arise; these measure just 11 inches in length; they are straight, and appear obscurely jointed, joints long. The plumose filaments are lateral and numerous; they are compound; that is to say, from two to five spring from the same base; but the common basal portion is very short; towards the anal orifice they are generally given off in pairs. The terminal portion of the body is destitute of filaments; the anal orifice is oval, central, and terminal.

Colour (as seen some days after death, preserved in sea-water). Head and horns of a bright brown colour; body, seen through the glistening investing membrane, of a dark olive-brown, with circular stripes of a lighter hue; ovisacs greyish white; plumose appendages deep black, but the clear integument investing these gave the terminal points of each the appearance of being tipped with silver.

Male unknown.

Habitat. In the body of *Orthagoriscus mola*, on either side of the dorsal fin. Cork Harbour, November 1869.

Total length of the perfect specimen examined, from top of head to anal opening, 7 inches.

I am indebted for this species to my friend Dr. Harvey, of

Cork, one of the few medical men of Ireland who never, amid the exigencies of a large professional practice, forget the interests of science. He informs me that the two specimens were found projecting from a circular depression in the thick skin of a young sunfish, near to its dorsal fin; they were buried in the skin and muscle of the fish to an extent of three inches. One specimen was broken off in removing it. There were also two specimens of *Tristoma coccineum* adhering to the head of the fish.

I have compared this species with all those of which I could find an account. Some figures and descriptions, like those in the 'Voyage de la Peyrouse,' represent species which it would be impossible to determine without the aid of the original specimens. The largest species described, and the one that I think approaches nearest to *P. orthagorisci*, is the *P. pustulosa*, Baird. This species was originally published in Angas's 'Savage Life and Scenes in Australia;' but Dr. Baird's description was copied into the 'Annals,' ser. 1. vol. xix. 1847, p. 280; the woodcut is not very characteristic. The specimen was found buried in a dolphin's body, near its gills (the dolphin was captured in lat. 11° 54′ S., long. 27° W.); the length was 4 inches. The plumose appendages are described as simple, and the abdomen as being of a very dark purple colour, and studded all over with small whitish pustules. If there be no mistake in the description of the plumose appendages, the species from the dolphin is not the same as that from the sunfish. Dr. Baird informs me that he examined a specimen of *Pennella* from a sunfish captured at Megavissey, Cornwall, which he refers to *P. filosa*, Linn. This will have been, I think, the first instance of the capture of this species on the coast of Great Britain.

Professor Claus* figures the eye of a species of *Pennella*, which he found placed below the cheliform antennæ. He describes it as consisting of a collection of pigment-cells covered by three clear cornea-like portions—one central, and one on either side. I cannot find, on a close examination of two specimens of *P. orthagorisci*, any appearance of a corneal structure. In the place indicated by Professor Claus there is a collection of pigment, which certainly acts as an eye, and there are obscure traces of the pigment matter being arranged into a series of hexagonal facets. The feathered antennules (or appendages to the second cephalic somite) were distinctly to be seen on both specimens examined. I cannot find that they have been described or figured as occurring in any species of *Pennella*. Their existence is a matter of some little interest; for we thus find the

* *L. c.* p. 5, pl. 2. fig. 10.

first three and most constant segments of the head represented by their appendages, though these are diminished to a very minute size, so as not, in *P. orthagorisci*, to be visible to the unassisted vision. As we also find four out of the five pairs of thoracic appendages present, it is pretty plain that it is chiefly the ordinary oral appendages, or rather those appendages usually modified for the purpose of assisting in the prehension and mastication of food, that become altered into the strange-looking arborescent follicles met with around the mouth.

EXPLANATION OF PLATE I.

Fig. 1. *Pennella orthagorisci*, ♀, natural size. (The specimen has shrunk, from being preserved in spirits.)
Fig. 2. Head, enlarged, dorsal aspect.
Fig. 3. The same, ventral aspect.
Fig. 4. Eye-spot (*a*), antennules (*b*), antennæ (*c*).
Fig. 5. Anal orifice.
Fig. 6. Head of second specimen, showing the comparatively short horns.

VIII.—*On* Janassa bituminosa, *Schlotheim, from the Marl-Slate of Midderidge, Durham.* By Albany Hancock, F.L.S., *and* Richard Howse.

[Plates II. & III.]

Through the obliging kindness of Joseph Duff, Esq., who has been for many years actively investigating the fossil flora and fauna of the south of Durham, we have lately had an opportunity of thoroughly examining the structure of the jaw-teeth and shagreen skin of this most interesting addition to the fauna of the English Marl-slate, which is the exact equivalent of the German Kupferschiefer.

Four groups of these remarkable jaw-teeth have been obtained by Mr. Duff at Midderidge—the first group in the year 1865, and the others during the autumn of the present year, 1869. These are, we believe, the first and only specimens that have been discovered in England.

But in Germany this species has been frequently found in the Kupferschiefer, which is very much worked, on account of the valuable copper-pyrites which it contains, in numerous localities; and consequently the general appearance of these teeth must be well known to those who are familiar with the works of Schlotheim, Münster, Geinitz, and others. According to the last-named author, the beautiful specimen still preserved in the Dresden Museum was well figured in the Dresden Magazine in the year 1762. Afterwards, in the year 1820, it was described by Schlotheim as a Trilobite, under the name *Trilobites bituminosus* (Petrefactenkunde, p. 39); and in 1823 two figures were given by this author, in his 'Nachtrag' ii. tab. 22. f. 9 *a*, 9 *b*.

Between the years 1833–1843, Count Münster figured and described numerous examples of the strongly characterized teeth and the shagreen skin of this peculiar fish under two or three generic and five or six specific names. These teeth were by him supposed to be palatal (an opinion which seems to be entertained by later German authors), and to belong to a fish of the Placoid order. After carefully examining the descriptions and figures given by Count Münster, we fully agree with those writers who consider that the following references belong all to one species, and we also are quite assured that the specimens obtained from the English Marl-slate are perfectly identical with those described by this author in his Beiträge zur Petrefactenkunde:—Heft i. *Janassa angulata*, p. 67, Taf. 4. f. 1, 2; *J. Humboldii*, p. 122, Taf. 14. f. 4; *J. bituminosa*, Schloth. p. 122. Heft iii. *J. angulata*, p. 122, Taf. 3 & 4. f. 5 *a*; *Dictea striata*, p. 124, Taf. 3 & 4. f. 1, 3, 4; Taf. 8. f. 3, 4, 6, 7, 8, 9, 10. Heft v. *Janassa dictea*, pp. 37–39, Taf. 15. f. 10–16. *Byzenos latipinnatus*, Heft vi. p. 50, Taf. 1. f. 2.

About the same time, *Janassa* was briefly described by Agassiz under the name of *Acrodus larva*, Poiss. Foss. iii. pp. 147, 174, 376, tab. 22. f. 23–25; and this learned author for the first time pointed out the probable affinities of these remarkable fish-remains.

Later German authorities, and especially our friend Dr. Geinitz, had already arrived at the conclusion that the various species of *Janassa* and *Dictea* described by Count Münster must all be brought back to one form, to which, by right of priority, Schlotheim's specific name should be attached. Indeed Dr. Geinitz has so recently (Dyas, 1861) examined and carefully commented on the various species described by Count Münster, that we think it better to give a translation of his remarks than to offer detailed ones of our own, especially as Dr. Geinitz would have the advantage of seeing many of the German specimens, and as we do not, excepting in one or two points, differ in opinion from the conclusions arrived at by this excellent naturalist. In fact Münster himself seems to have been satisfied that his genera *Janassa* and *Dictea* were identical, and also to have had some doubts as to the value of some of the species which he has made of *Janassa bituminosa*. Dr. Geinitz observes:—

"The beautiful original of *J. Humboldti* in the Dresden Museum (Dyas, tab. 4. f. 5), of which a very good figure was given in the year 1762 in the 'Dresden Magazine,' and which happily was recovered from the ashes of the fire at the Zwinger, is again figured here, because Münster's figure is reversed. This still beautiful specimen deserves a new illustration, because it furnishes a proof that not only all Count Münster's species of *Janassa*, but also his *Dictea striata*, must be referred to the type to which the first name given by Schlotheim belongs.

"The oval, uniformly arched palate (Gaumen) is paved with from five to seven rows of chisel-formed, strongly curved at their upper enamelled end, and nail-shaped recurved teeth, which are indistinctly imbricated, and which are separated by a deep furrow into an anterior and a posterior division.

"In the teeth of the anterior division the nail-formed end is bent backwards to the throat (*ib.* tab. 5. f. 3), in those of the posterior, on the contrary, forwards (*ib.* tab. 5. fig. 4). The three middle rows of the anterior division, of which each one has six teeth, the size of which increases from before backwards, contain generally the largest teeth: only these three rows have been figured by Schlotheim, who thought he saw in them the structure of the Trilobites. On each side lie two more rows of smaller teeth, which stand obliquely to the primary rows, and of which the outer ones only appear to be lamelliform*. They are not shown in Münster's figure of *J. angulata* (Beitr. i. tab. 4. f. 1, 2). In Beitr. iii. tab. 3 & 4. f. 5, they are only partly to be seen; but on the *J. Humboldti* they are better shown, while in Münster's *J. Dictea* (Beitr. v. tab. 15. f. 10) they stand a little separated, certainly from the result of dislocation.

"The posterior shorter group of teeth, which in Münster's figure (Beitr. v. tab. 15. f. 10) is represented as correctly as possible, contains as many longitudinal rows of teeth as the anterior division, which in size decrease backwards and stand in five transverse rows. Their upper enamelled end seems in all to be bent forwards, or in the opposite direction to those of the anterior group of teeth. Münster ascribes such a curvature to two teeth only, which in his specimen are situated immediately between the two divisions of the palate and out of place (Beitr. v. p. 39, tab. 15. f. 13, *g*, *h*); but he announces expressly that this palate is a little drawn out and dislocated, for which reason the teeth are not in their usual regular position.

* The lamelliform teeth of Geinitz are those we have named petalodontoid.

"In our *Janassa*, the original of *J. Humboldti*, Münster, all the remaining teeth of the first cross row of the posterior division, from the line *a b*, have an equal curvature forwards of their upper part. The teeth of the cross rows standing behind them are only marked by broken roots. This specimen shows yet another character of the genus *Janassa*, which has not yet been described in any other specimen. At the posterior part of the head, or rather at the entrance of the throat, there are two large, similarly formed, bent teeth (*d d*), like all the others of the posterior division, which Count Münster took for ear-bones (Beitr. i. 1843, p. 122).

"On the specimens which are broken through parallel to the palate-plate, as in 'Dyas,' tab. 5. f. 1, the six-sided form of the teeth shows itself clearly; but the boundary between the anterior and posterior divisions of the teeth shows itself also on these very distinctly, as the front teeth of the former have the anterior side concave and the hinder convex; but on the latter this appears reversed (*ib.* tab. 5. f. 1). In Münster's figures this relation is only taken into consideration in *J. Dictea.*

"In our *J. Humboldti* (*ib.* tab. 4. f. 5) the first cross row of teeth of the posterior division is by pressure driven close to the last cross row of the anterior division, and partly under it, for which reason one cannot see the separating furrow; and Count Münster has felt himself justified in placing *J. Humboldti* with *Dictea* (Beitr. v. p. 38).

"From the similar form of the teeth of Münster's *Janassa* and *Dictea*, of which the structure is always tubular, while the outer surface of the root shows more or less distinct transverse roots (Dyas, tab. 4. f. 5, *c*, and tab. 5. f. 1), and from the perfectly similar arrangement of the teeth in *J. angulata*, *J. Dictea*, and *J. Humboldti*, Münster, with that in our figures, which cannot be recognized in Münster's ideal and quite incorrect figure (Beitr. iii. tab. 3 & 4. f. 2), there can exist no doubt whatever as to the identity of both genera and the five different species in them.

"In *Dictea striata*, Münster (Beitr. iii. tab. 3 & 4. f. 1), the whole contour of the fish appears before us, though the swimming-appendages which surround the body permit a different explanation, because this specimen lies more on the belly. The length of the fish, without the caudal fin, is 0·390 metre; the height of the head 0·080 metre, the body at the pectorals, not including these, 0·071 metre; the greatest width between the ventrals and the pectorals 0·110 metre, at the anal fin 0·055 metre, and at the base of the tail 0·035 metre broad. The whole body and all the fins or swimming-enlargements are covered with a fine shagreen skin.

"The specimen shown (Dyas, tab. 5. f. 1) widens out at the back of the head on each side in an arched, triangular, wing-shaped, blunt process (*c c*), which may represent the cross bone (*os transversale*).

"*Byzenos latipinnatus*, Münster, 1843 (Beitr. vi. tab. 1. f. 2, p. 50), from the Kupferschiefer of Richelsdorf, is a fragment covered with fine shagreen, but which does not admit of a perfect description, and which might just as well be referred to *J. bituminosa* as to any other genus of fish."

With the above remarks we entirely concur, excepting the statement that the teeth of *Janassa* are palatal, as it is proved, by their relationship to *Myliobates*, that they are true jaw-teeth. The other remark that does not appear to us satisfactory is, that the two bodies designated by Count Münster ear-bones are considered by Dr. Geinitz to be teeth placed near the entrance of the throat. The specimens from our locality do not show a trace of these peculiar bodies; but we are disposed to consider them casts of a pair of cranial cavities rather than teeth. That they are not teeth seems to be clearly indicated by the entire absence of enamel covering, as pointed out by Count Münster. Dr. Geinitz has also incorrectly classified this fish with the Cestracionts; but, by the observations made in a former paper, it will be seen that we agree with Professor Agassiz in placing *Janassa* among the Rays.

We now, after these introductory remarks, proceed to give a general description of the oral armature of this curious fish, and, in conclusion, a special description of the several specimens obtained by Mr. Duff.

The dental apparatus of *Janassa bituminosa* is very peculiar; it cannot, however, be distinguished generically from that of the so-called *Climaxodus linguæformis*, Atthey, the Coal-measure representative of Münster's genus; and for a comparison of the two we would refer to the previous paper on the subject, published in the November Number of the 'Annals'*.

The teeth of the fish now before us, like those of the Coal-measure species, are of two kinds, primary and secondary, the latter being petalodontoid in form. The largest of the primary, including the root, are $1\frac{1}{4}$ inch long and $\frac{1}{2}$ inch wide;

* Hancock and Atthey, "On the Generic Identity of *Climaxodus* and *Janassa*." In the figure of the restored row of teeth of the so-called *Climaxodus linguæformis* illustrating the former paper, the under row is represented as in advance of the upper, purposely to indicate its relation to the latter. But the specimen clearly demonstrates the fact that the upper row projects a little in advance of the under, as is the case in *Janassa bituminosa*.

they are elongated, somewhat depressed, ovate, tapering a little posteriorly, and have the surface divided into two well-marked portions—an anterior scoop-like cutting-margin, and a posterior ridged crushing-surface or disk, with a long depressed root extending backwards (Pl. II. figs. 2, 4, 5). The scoop-like cutting-margin is considerably more than one-fourth the entire length of the crown; it projects upwards and forwards, and is smooth and concave, with the edge usually obtuse and arched or a little sinuous from wear, but when comparatively fresh is pretty regularly arched, and when quite perfect is probably denticulated, if we may judge from the small lateral teeth. The crushing-surface or disk is elongated, the sides being nearly parallel, though tapering to a blunt point behind, the general form resembling that of a lengthened shield. The surface is convex, and is covered with about twenty close-set transverse ridges, imbricated forwards, and irregularly undulated, notched and tuberculated, and arched forwards at the sides.

The scoop-like cutting-margin and the crushing-disk we shall call the upper surface, these being, in fact, the only exposed portions, though in reality they represent the surface that is usually considered the back of the tooth. The other or opposed surface, which in ordinary cases would be called the front, we shall name the under surface, because it is undermost as the tooth rests on the jaw. The under surface, then, presents a very peculiar appearance: it is divided into three sharply defined, longitudinal, flattened areas or facets; so that in transverse section this side would show as half a hexagon. The central area, which is divided from the two lateral areas by a ridge or angle, is usually a little channelled. The back of the scoop-like cutting-margin is also a little flattened at the sides and centre.

The root is a depressed process, longitudinally striated, somewhat narrower than the crown, and about half its length; it originates in the under surface near to the posterior extremity, and arches backwards and downwards. It is consequently an extension, as it were, of the crown in a plane below the crushing-disk.

When seen in profile the primary teeth are observed to assume a decided sigmoid curve, the anterior scoop-like cutting-margin being turned rather abruptly in one direction, and the posterior extremity of the crushing-disk and root in the other or opposite direction (fig. 4).

The large primary teeth, which hold a central position, are symmetrical; the smaller lateral ones, though they agree in every other respect with the above, are more or less oblique, the sides being unequal, particularly the scoop-like portion, one side of which is more developed than the other. And the root likewise is turned a little to one side, especially in the second lateral.

The secondary or petalodontoid teeth are not more than $\frac{3}{8}$ in. long, and about the same wide; they are depressed and partake otherwise of the general characters of the primary teeth. They are more inequilateral and oblique than the smaller primaries, one side being much more arched than the other. The cutting-margin is slightly arched and denticulated, but is narrow and only a little concave; the crushing-disk, too, is wider than long, the transverse, imbricated ridges being reduced to about half a dozen.

The upper surface of all the teeth, whether primary or secondary, is covered with a thick layer of opaque white enamel-like matter. This has a very striking appearance, contrasting as it does with the dark hue of the rest of the tooth, and being strongly defined around the margin by a thickened rim, which is best seen when the tooth is turned with its face downwards.

And, moreover, when the enamelled surface is a little worn, it becomes pitted and freckled all over with dark irregular points, which are sometimes elongated, particularly on the anterior or cutting-margin.

There is little difficulty in determining the manner in which these curious teeth are placed in, or rather on, the jaws; for apparently the whole of the teeth of both jaws have been found lying in their original position, though the jaws themselves have entirely disappeared, they having undoubtedly been composed of cartilage. Having carefully examined Mr. Duff's specimens, which will shortly be described, and after a full consideration of Count Münster's figures and descriptions, we can have little hesitation in giving the following account of the arrangement of these rather extraordinary dental organs—and this notwithstanding that we are acquainted with nothing exactly like it, either in fossil or recent fishes, except in the so-called *Climaxodus*.

First, then, the teeth are arranged in both upper and lower jaws (Pl. II. figs. 2, 3) in precisely the same order. In both they are placed in transverse horizontal rows, across the anterior portion of the jaws, and in such a manner that never more than a single row in each jaw is in operation at the same time. Each such horizontal row is composed of seven teeth (five primary, two secondary), placed lengthwise, with the cutting-margin in front. A large symmetrical primary tooth is situated on the longitudinal median line, or exactly over the symphysis; on each side of this central tooth are a first and a second asymmetrical primary tooth, making up the five primaries. These are flanked on either hand with a single secondary or petalodontoid tooth, completing the full complement of seven. They diminish in size from the centre, the flanking petalodontoid teeth being quite small in comparison with the large central primary tooth.

The rows are placed one above the other in horizontal ranges, the lower rows acting merely as mechanical supports to the upper row, or that which was alone employed in cutting and crushing the food. There are from four to seven such horizontal rows, the teeth diminishing in size downwards, the lower ones having been first developed, and in succession having had their period of active operation. As they wear out (that is, as the cutting-margins become blunt, and as the imbricated ridges of the cutting-disks are obliterated or reduced), a new row is developed behind, and, rising up, falls forward, and rests upon the row last in use; while at the same time the dentigerous membrane is pushed forward, and the oldest row, the lowest in the series, or that which was first developed, falls away. Thus, by this double action of growth and decay perpetually going on, there is always an efficient row at the surface, able to initiate the process of alimentation, sustained at a proper elevation on a firm basis.

This constant renewal of the oral armature is nothing extraordinary, as it is common to all the Sharks and Rays, the close allies of *Janassa*. But that the new set of teeth should overlie and be supported by the old ones is indeed without a parallel, so far as we are acquainted with the subject of ichthyic dentition, with the exception of the so-called *Climaxodus linguæformis*; and that interesting Coal-measure species has been shown to be a true *Janassa*, in the paper previously quoted from the November number of the 'Annals.' The only instance that occurs to us in which something similar is found, is seen in the Greenland Shark, *Squalus borealis*, in which the older teeth of the lower jaw lie in front of and give support to the last-developed or those in use. Teeth of *Petalodus*, we believe, have also been found lying in regular order, as if forming a portion of a vertical row.

This curious pile of teeth forms a close, dense mass, increasing in size upwards, or as the last-developed teeth are approached—the smaller rows of teeth, as already stated, being below; and the teeth themselves are, as it were, interlocked. The central teeth of each horizontal row are the only ones that are placed exactly above each other; the lateral teeth of the successive rows are arranged in quincunx; so that they may be looked upon as forming slightly diverging diagonal lines, having the central teeth as their starting-point. Now, the first primary lateral teeth, or those next the centre, underlie to some extent the under surface of the central teeth; and the second primary lateral underlie in a similar manner the margins of the first primary, and so with the third or petalodontoid teeth. Thus the whole mass becomes interlocked like a piece of masonry; or, if we take all the central teeth to form a vertical row, and consider in like manner the various lateral teeth, then it might be said that the teeth composing such vertical rows had their lateral margins insinuated between those of the adjacent rows.

In consequence of this interlocking and close approximation, the back or under surface of each tooth becomes worn, and the three longitudinal areas or facets, already described, become more strongly defined. The central area and the two lateral areas are in this way affected by the three teeth that conduce to the support of each superincumbent tooth. That this is the fact is apparently demonstrated by the central area being occasionally grooved transversely, corresponding as the grooves do to the imbricated ridges of the crushing-disk of the supporting teeth (Pl. II. figs. 1 & 5).

As a further proof that such is the fact, it may be observed that when the crushing-disk has by previous use been worn smooth, which frequently occurs, the central facet of the corresponding superincumbent tooth is likewise smooth. It is only when the ridges are retained that these impressions are observed in the upper teeth; and, indeed, were no other evidence at hand, it is patent enough that these peculiar facets are in part the result of wear; for they exhibit on their surfaces the internal structure of the matter composing the tooth. And that the opposing crushing-disk is not equally and mutually worn arises from the fact that it is covered with a layer of hard enamel-like matter.

The existence of the transverse grooves would seem also to prove that while they were produced by the rubbing-motion of the teeth upon each other, the motion itself must have been very limited, or neither the grooves nor the sharp definition of the facets could have existed. And in this way we have a corroboration that the retention of the old, effete teeth is merely for the mechanical support that they supply to the upper row of teeth, upon which teeth alone devolves the function of cutting and crushing the food.

The four groups of teeth obtained by Mr. Duff at Midderidge are very instructive, and, though in a more or less disturbed state, are quite sufficient to show the original disposition in the mouth. One of the specimens was quite perfect when found; but unfortunately an idle lad got hold of it, after the quarryman had carefully laid it aside, and in the mere lack of thought broke away a great number of the teeth. Happily, however, the anterior portions of nearly the whole of them are still left sticking in the matrix; so that not only their number can be ascertained, but likewise the exact limit of those belonging to the upper and lower jaws respectively, and their precise arrangement thereon.

This specimen of the buccal armature was not only complete when deposited, but is lying on the slab in its natural position; and probably when buried the whole fish was present, and lay with its back uppermost. Consequently, the mouth being situated beneath, as in the Sharks and Rays, the teeth of the overhanging upper jaw would lie in advance of those of the lower. Such is the case in the specimen now before us, as is determined by the presence of a quantity of shagreen, indicating as it does the direction in which the body of the fish was deposited. There are about three inches of this shagreen, extending from the posterior margin of the mass of teeth, or those which belong to the under jaw. And, in fact, there can be little doubt that, had the slab been continued backwards sufficiently far, we should have had an impression of the whole fish, marked out by the shagreen, similar to the figure given by Münster of his *Dictea striata*.

The cutting or anterior margins of the teeth are downwards, for the most part buried in the matrix. Many of the roots and, to a great extent, the crushing-disks having been removed, as before stated, the specimen is, as it were, hollowed out, and presents an oval, disk-like aspect, an inch and three-quarters long, and an inch and a quarter wide. The broken anterior portions of the teeth line this cavity in almost perfect order, as if observed from the interior of the mouth, their external or anterior extremities being turned from the observer. The group thus seen is divided into two portions, an anterior and posterior. The teeth of the former or upper jaw have their faces or anterior scoop-like cutting-margins and crushing-disks, or as much of them as is left, turned downwards, and are closely packed together in five horizontal rows of seven teeth each. The central teeth of the five rows rest one upon the other in the median antero-posterior line, diminishing in size forwards and upwards as the specimen is seen. These five central teeth are flanked on either side by three others, which likewise diminish in size in front. These teeth, of which there are in all thirty-five, as already stated, belong to the upper jaw. A similar cluster of teeth belongs to the under jaw, and composes the posterior half of the general batch. These are arranged in the same fashion as those of the upper jaw; but instead of having the anterior scoop-like cutting-margins turned downwards, they are placed in the opposite direction, looking upwards. The anterior margins of the two sets of teeth meet in the transverse middle line, and are pressed close together, so that the entire batch is continuous, there being no hiatus anywhere, the mouth, in fact, being closed, and the teeth of the two jaws pressed together. In the under jaw there are likewise five horizontal rows of seven teeth each, though, on account of the injury the specimen has sustained, the exact number is not so easily determined as it is in the other jaw.

This specimen has apparently been as complete as that figured by Münster (Beitr. Heft v. Taf. 15. figs. 10, 11) under the name of *J. Dictea*, and is, indeed, a very good counterpart of the specimen there represented; only in ours the front or scoop-like cutting-margins of the teeth are buried in the matrix, the view of the specimen being obtained as it were from the oral cavity; while Count Münster's figure has the front of the teeth exposed, as they would be seen had the fish been laid upon its back.

Another of Mr. Duff's specimens (Pl. III. fig. 1), however, presents the same aspect as that of the figure just referred to, and is almost perfect, rising as that does in bold relief from the matrix, in the form of an irregularly rounded cluster, having the peculiar vesicular appearance seen in most of Münster's figures. This appearance is very remarkable, and at first sight has, as was suggested to us on showing the specimen to a friend, no little resemblance to a cluster of ova-capsules of *Fusus antiquus*, particularly when the teeth are a little disturbed.

In connexion with this cluster of teeth, a large patch of shagreen is beautifully displayed, and enables us to determine, in like manner as in the former instance, which is the anterior margin of the specimen, the spreading of the shagreen indicating the direction of the body of the fish.

In this specimen, as in the first-mentioned, the teeth are divisible into two sets, which have their cutting-margins opposed to each other across the transverse median line. Those of the anterior set belong to the upper jaw, and are closely packed together and interlocked in the manner previously described, in four transverse or horizontal rows; the remains of a fifth row are distinctly visible. The arrangement is the same as in the first-described specimen: that is, in each row there is a central tooth with three lateral ones on each side, the extreme flanking tooth on either hand being petalodontoid in form; and the teeth composing the row next the transverse median line are the largest, while those in front, or those in the lower supporting rows, become gradually smaller.

The teeth of the lower jaw, or those at the posterior margin of the cluster, are in a comparatively disturbed state; but the anterior cutting-margins are turned forward, so as to oppose those of the upper jaw, whose cutting-margins are turned backwards. In the lower jaw four horizontal rows are distinctly determinable, while indications of a fifth can be traced. On account of the disturbance of these teeth, the central large teeth of four rows are well displayed in profile, being turned over towards the right of the observer, and lying in regular order, one behind the other, so that the whole length of the teeth is exposed, the roots being traceable in the matrix. Several of the lateral teeth are scattered on either side, and three or four are removed to some distance to the left.

This specimen is fortunately broken through transversely near the centre, in such a manner that the greater portion of the upper or crushing-disks, with the anterior cutting-margins of one row of teeth and the backs or under-surfaces of another, are finely displayed. And thus we obtain a clear demonstration of the arrangement of the teeth in this fine specimen, and at the same time a complete exposition of the characters of the teeth themselves.

A third slab exhibits a dense mass of teeth of an irregularly rounded form, comprising numerous teeth of both jaws (Pl. III. fig. 2). Here, again, the shagreen shows the position in which the body of the fish was deposited; but as all the teeth have the anterior scoop-like cutting-margins in one direction, there can be no question as to which is front. The specimen rests on the slab with the face uppermost, much as in the last case; only the whole are turned forward, and, unlike it, the teeth are in a much disturbed state, particularly those of the under jaw, which lie uppermost. These, or at least all that remain of them, have been pushed so far forward that they overlie those of the upper jaw towards the left side, leaving exposed the upper surface of the large central tooth and the first lateral of the working row of the upper jaw, which are well exhibited in their true position; and the remains of a second lateral tooth and one or two of the petalodontoid form are seen at the extreme right. These exposed teeth of the upper jaw have their crushing-disks and cutting-margins turned upwards; and their roots are well displayed, sinking backwards into the matrix. The few teeth of the under jaw already spoken of on the left have their under surfaces or backs exposed, the crushing-disks being turned down to oppose those of the upper jaw. At the posterior part of the general mass several of the second primary and petalodontoid teeth lie scattered about, chiefly with the under surfaces uppermost.

The remaining specimen (Pl. II. fig. 1) to be noticed, though consisting of only a few teeth, is very interesting, inasmuch as it displays in profile an entire vertical row, lying in almost exact order, one resting upon the other. The whole length of the teeth is seen, from the cutting-margin to and including the root, bent in a deep sigmoidal curve. The series appears to be of the central teeth: four lie in close contact, the back or under surface of one individual resting upon and fitting exactly to the face or upper surface of that immediately below it. A very imperfect fragment of a fifth tooth is seen pressed to the under surface of the fourth of the series; and in front considerable portions of two lateral primaries lie with their under surfaces uppermost, one of which exhibits in a remarkable manner the transverse grooves caused by the rubbing of the crushing-disk of the tooth on that supporting it. Similar transverse grooves can be seen on one or two other teeth of the series. A considerable fragment of a second primary lies near the centre of the row.

The minute structure of the teeth is rather peculiar; and though we have not examined it in the entire tooth, and though our account of it must necessarily be imperfect, as it is from mere fragments, yet we cannot refrain from saying something on the subject.

We have stated that the upper surface (namely, the anterior scoop-like margin and the crushing-disk) is covered with a layer of opaque-white enamel-like matter. This coating is thickest over the crushing-disk, where it is of a considerable depth. When the tooth is quite fresh, there appears to overlie this a thin film of transparent enamel. The interior is composed of a rich brown-coloured substance, which may be looked upon as a form of dentine, made up of large, branched and anastomosing tubes with thick walls, which, for the most part, run lengthwise; their cavities are undoubtedly medullary channels; they are narrow in proportion to the thickness of the entire tube. These give off, almost at right angles, small, irregular, branched and anastomosing tubes, which, penetrating the overlying white enamel-like matter, abut near to the surface. The white matter also penetrates occasionally into the interior of the tooth, insinuating itself between the tubes; but the central portion is usually so exceedingly dense that few traces of it are to be observed. On the upper or concave face of the cutting-margin, however, the dentinal tubes, which are here small and arranged lengthwise in parallel order, lie buried in the white matter that in many instances permeates the entire scoop portion.

The tubular matter, whether at the surface or in the interior, is composed of concentric layers; and coarse, branched tubules, originating in the medullary channels, penetrate their walls. The whole of the brown tubular matter composing the mass of the tooth is probably dentine, as we have just stated; or it may be, as stated in the paper already quoted on *Climaxodus* and *Janassa*, osteodentine, the small marginal tubes only being dentine; but the structure of the whole appears to be the same. We feel equally at a loss how to denominate the white matter*. It is minutely granular, but otherwise quite structureless. If we are correct in designating it enamel, then there must be two kinds of enamel; or what is the transparent film seen on the surface in perfect specimens?

When the white coating is worn a little, the extremities of the small dentinal tubes that penetrate it are seen at the surface; and as they wear more readily than the white matter, the whole surface becomes minutely punctured. On the cutting-margin, however, the white matter is usually to some extent minutely grooved longitudinally, in consequence of these superficial tubes of the dentine-like matter running parallel to the surface.

The minute structure of the tooth as above described is seen to be essentially the same as that of the so-called *Climaxodus*; but in the latter the brown dentinal tubular matter of the interior is not so dense, consequently the white matter penetrates more extensively through the tissue. The small dentinal tubes abutting at the surface, too, are more branched and are less regular. The external white layer appears to be not so thick; but it is almost always so much stained with black carbonaceous matter that it is not easily distinguished. Indeed we have only in one instance detected it without the aid of transmitted light; but in section when so viewed its presence is usually observed.

The shagreen (Pl. II. fig. 6) with which the body of this fish is covered is exhibited in three of the four specimens obtained by Mr. Duff. In one of them a considerable patch of it is very beautifully displayed, no disturbance whatever having taken place in the tubercles. They are minute, and, though pretty close together, they are seldom in contact, there generally being

* In the paper on *Climaxodus* and *Janassa* this white coating is called "cement." On further examination, however, we find that it has not the character of cement, but is merely granular, and in every respect is similar to the white external layer in *Janassa*.

a space between them less than half their diameter. They are in the form of irregularly rounded bosses, with the surface smooth and glossy, and the margins sinuous and produced into points. Sometimes, however, they are much elongated, and are frequently very irregular in shape, with the marginal prolongations much produced, variously formed, sharp or obtuse. Others have one margin comparatively smooth, the points being confined to the opposite side. Some are quite devoid of all such irregularities, the margins being smooth or only a little sinuous at one side; these are rounder and larger than the others (fig. 8). Another form (fig. 7), not by any means uncommon, is irregularly stellate, with the rays ridged and sometimes a little bifurcated.

From the fineness of the cutting-margin in the so-called *Climaxodus*, it was inferred in the former paper, so frequently referred to, that the food must have been composed of some soft material. We are disposed to draw the same conclusion from the structure of the teeth of *Janassa bituminosa*. The scoop-like cutting-margin is certainly much used, for it is almost always greatly worn in a regular manner; only in one instance have we seen it a little broken. It would be an efficient instrument in cutting vegetable substances, and these might afterwards require the aid of the crushing-disk.

In corroboration of this view of the food, we may quote a passage from Münster, who says, of his *Byzenos latipinnatus*, that "the intestine seems to have been very full when the fish died. It is more elevated than the other parts of the body. On some places one sees in the interior a black earthy mass in which small pointed bodies appear, which are like small pieces of shiny coal." May not this "black earthy mass" and "pieces of shiny coal" be carbonized vegetable matter, the food of the fish?

It is unnecessary here to dilate on the affinities of *Janassa*, as the subject is discussed in the former paper, already quoted. We may remark, however, that the full investigation of the Permian species has only the more confirmed our opinion of its close alliance with the Coal-measure form (the so-called *Climaxodus linguæformis*), and of a certain relationship of both to *Myliobates* and *Zygobates*.

We may also state that *Janassa* is more closely related to *Petalodus* than was at first thought; for we now find that the latter genus is provided with both symmetrical and oblique teeth; so that it is quite probable that they may be found to be arranged in much the same manner as those of *Janassa*, especially as the former have been found in vertical series, as previously stated.

EXPLANATION OF PLATES II. & III.

Plate II.

Fig. 1. Somewhat enlarged view of a central vertical row of teeth of *Janassa bituminosa*, seen in profile and exhibiting transverse grooves and ridges on the underside: *a*, under surface, with transverse grooves, of apparently two lateral teeth; *b*, a portion of a second lateral tooth.

Fig. 2. Horizontal row of teeth of the same, a little enlarged: *a*, anterior scoop-like cutting-margin; *b*, crushing-disk; *c*, root; *d*, first lateral tooth; *e*, second ditto; *f*, flanking petalodontoid tooth.

Fig. 3. Diagram showing the central vertical row of teeth in profile, and to explain their relationship to the jaws: *a*, supposed upper jaw; *b*, supposed under jaw; *c*, the teeth in use; *d*, effete supporting teeth.

Fig. 4. Profile view of a central tooth, somewhat enlarged: *a*, anterior scoop-like cutting-margin; *b*, crushing-disk; *c*, root.

Fig. 5. View of underside of central tooth: *a*, cutting-margin; *b*, central area or facet, exhibiting transverse grooves; *c c*, lateral facets; *d*, root.

Fig. 6. Shagreen, tubercles much enlarged, in their natural order.

Fig. 7. Three stellate tubercles of the same.

Fig. 8. Two smooth tubercles.

Plate III.

Fig. 1. A group of teeth, a little over the natural size, of *Janassa bituminosa*, seen in front, the anterior cutting-margins being exposed: *a*, central row of teeth of upper jaw; *b*, of under jaw, with their sides exposed; *c*, petalodontoid teeth; *d*, shagreen.

Fig. 2. Another group: *a*, the upper surface of two teeth of the upper jaw; *b*, the remains of teeth of the under jaw, with their under surfaces exposed; *c*, scattered petalodontoid teeth, with their undersides uppermost.

IX.—*Description of a supposed new Species of Pigeon.* By John Gould, F.R.S.

Genus Otidiphaps, Gould.

Size large, equalling that of a wood-pigeon, *Columba œnas*; *bill* longer than the head, straight, and plover-like; *wings* short and round, armed with a spur at the shoulder; *tail* round and moderately long; *tarsi* very long for a pigeon, and with the *toes* covered with thick plate-like scales; *nails* somewhat straight and pointed; general structure adapted for the ground rather than for trees or for flight.

Otidiphaps nobilis, Gould.

Bill red or fleshy red, particularly on its basal portion; round the eye a bare space, which appears to have been of the same colour; crown of the head and occipital crest black, with steel-blue reflections; back of the neck resplendent glaucous green;

breast and under surface purple; back and wings rich chestnut, with violet reflections when viewed in certain lights, and passing into golden bronze at the nape; rump and upper tail-coverts rich purplish blue; tail blackish green; legs yellow or reddish yellow.

Total length 16 inches; bill $1\frac{1}{4}$, wing 7, tail $6\frac{3}{4}$, tarsi $2\frac{3}{4}$.

I obtained this fine bird of Mr. James Gardner of Holborn, who could not inform me of the precise locality in which it was collected; but as it was accompanied by *Paradisea papuana*, *Epimachus maximus*, many specimens of *Semioptera Wallacei*, and *Pitta maxima*, it was probably procured on some one of the islands of the Eastern Archipelago or in New Guinea. Although the bill is not toothed, this species appears to be allied to *Didunculus*.

MISCELLANEOUS.

Deep-sea Researches.

To the Editors of the Annals and Magazine of Natural History.

Gentlemen,—You will oblige me, and at the same time, I believe, further the interests of scientific truth, by inserting the following observations in the 'Annals.'

In a note which appeared in 'Nature,' of Dec. 16th, p. 192, Mr. Gwyn Jeffreys makes known his views on the "*Food of Oceanic Animals*" in these words:—

"The receipt of an interesting paper by Prof. Dickie, entitled "Notes on range in depth of marine Algæ," lately published by the Botanical Society of Edinburgh, induces me to call the attention of physiologists to the fact that plant-life appears to be absent in the ocean, with the exception of a comparatively narrow fringe (known as the littoral and laminarian zones) which girds the coasts, and of the "Sargasso" tract in the Gulf of Mexico.

"During the recent exploration, in H.M.S. 'Porcupine,' of part of the North Atlantic, *I could not detect the slightest trace of any vegetable organism at a greater depth than fifteen fathoms. Animal organisms of all kinds and sizes, living and dead, were everywhere abundant, from the surface to the bottom*; and it might at first be supposed that such constituted the only food of the oceanic animals which were observed, some of them being zoophagous, others sarcophagous, none phytophagous. But inasmuch as all animals are said to exhale carbonic acid gas, and on their death the same gas is given out by their decomposition, whence do oceanic animals get that supply of carbon which terrestrial and littoral or shallow-water animals derive, directly or indirectly, from plants? Can any class of marine animals assimilate the carbon contained in the sea, as plants assimilate the carbon contained in the air?

"Not being a physiologist, I will not presume to offer an opinion; but the suggestions or questions which I have ventured to submit may perhaps be worth consideration. At all events the usual theory, that all animals ultimately depend for their nourishment on vegetable life, seems not to be applicable to the main ocean, and consequently not to one-half of the earth's surface.

"J. Gwyn Jeffreys."

It is quite unnecessary for me to criticise the remarkable opinions here offered regarding the Sargasso tract, the chemistry of decomposing animal matter in the ocean, and the relative proportions of land and water on the globe. It will be seen that they are unique. But as Mr. Jeffreys has entered the lists as an authority on deep-sea lore, and now claims as his own the discovery that plant-life is absent in the deeper regions of the ocean, and the refutation of the theory (as applied to the inhabitants of the sea) that "all animals ultimately depend for their nourishment on vegetable life," I must be excused if I endeavour to show that he has either forgotten what, at a not very remote period, he professed to have read of my writings on these subjects, or that, not having forgotten them, he has nevertheless found it expedient, for some unaccountable reason, to repudiate them, and with them his own published estimate regarding their accuracy.

The absence of all living vegetation, even of the lowest types, in the deeper abysses of the ocean, and the vital process whereby the nutrition of the lowest animal forms is secured in failure of anything like a rudimentary digestive apparatus, such as is to be found in the higher orders of Rhizopods, was dwelt on by me in my 'Notes on the presence of Animal Life at great depths in the Ocean,' published in Nov. 1860, p. 27,—in my 'North-Atlantic Sea-bed,' published in 1862, pp. 130–132,—in a note which appeared in the 'Annals & Mag. Nat. Hist.' for Aug. 1863, p. 166,—and in two papers contributed by me to the 'Monthly Journal of Microscopical Science,' for Jan. 1869, pp. 39–40, and April of the same year, pp. 231–233. Reference to these publications will therefore show that Mr. Jeffreys's statements are, to say the least of them, somewhat behind the times.

But to prove that Mr. Jeffreys cannot justly plead ignorance as to what had been previously published by me on the subject, I invite attention to two extracts from his "Reports on Dredgings," contained in the 'Annals' of the respective dates given below.

'Annals,' Nov. 1866, p. 387.

"Dr. Wallich, in his admirable and "philosophical treatise with which all "marine zoologists and geologists are, "or ought to be, familiar, believed that "certain starfishes" &c. &c. "*As to "the accuracy of his statements, no reasonable doubt can be entertained.*"

'Annals,' Oct. 1868, p. 305.

"Coccospheres and free Foraminifera cover the bed of the Atlantic at "enormous depths. The occurrence, "therefore, of such organisms on the "floor of the ocean at great depths "does not prove that they ever lived "there. *I should rather be inclined to "believe that they dropped to the "bottom when dead or after having "passed through the stomachs of other "animals which had fed on them.*"

It is indisputable, therefore, that Mr. Jeffreys had studied my writings, and that the opinion entertained of them by him in 1866 was revoked in favour of that expressed by him in 1868; whilst that expressed in 1868 has again in its turn been superseded by the very positive contradiction it receives in his note in 'Nature' published a fortnight ago!

It is likewise deserving of special notice that Dr. Carpenter, who might be supposed to have made himself acquainted with the whole past literature of the subject, should, at p. 181 of the official copy of his 'Preliminary Report on Dredging for 1868,' have thought it expedient to single out from these two most conflicting statements that which was offered by Mr. Jeffreys in 1868 (see above), as evidence that "*Dr. Wallich's just claims had not by any means commanded the universal assent of naturalists*"—an assent to which, if just, as it has now been most clearly proved that they were and are, those conclusions were long ago entitled.

With regard to Mr. Jeffreys's division of oceanic animals into "zoophagons" and "sarcophagons," I have nothing to urge beyond my avowed inability to discern any valid physiological difference between those that are zoophagous and those that are sarcophagous. It rests with Mr. Jeffreys to explain on what grounds he has felt justified in declaring so emphatically that "*none*" of the animals "*of all kinds and sizes, everywhere abundant from the surface to the bottom*," observed by him in his exploration of the North Atlantic, were phytophagous.

It only remains for me to add that for years I stood alone in maintaining, in opposition to the opinion of Ehrenberg and his followers, that all plant-life becomes extinct at depths exceeding 400 or 500 fathoms, and that the nutrition of the Foraminifera and some other orders of oceanic Rhizopods is effected by a special vital function, whereby they are enabled to eliminate, from the medium in which they live, the elementary ingredients which enter into the formation of their body- and shell-substances. The facts and reasoning on which my observations were based will be found in the various published papers &c. already referred to.

I remain, Gentlemen,

Yours very faithfully,

G. C. Wallich.

Kensington,
December 24, 1869.

On the Specific Distinctness of Anodonta anatina.

To the Editors of the Annals and Magazine of Natural History.

Gentlemen,—There has been, and, I believe, still is, a diversity of opinion as to whether *Anodonta anatina* is a distinct species or only a variety of *Anodonta cygnea*. I have, since I commenced the study of conchology, inclined to the former view; and I think I am now able to bring forward evidence in favour of it which has not been adduced before. It has been maintained that these animals are varieties because no difference is to be found in their soft parts, excepting as regards the general shape, which corresponds to that of the shell. But I have observed, in *Anodonta anatina*, that the branchial opening is not only comparatively, but actually, much larger and fringed with much more delicate and numerous tentacles than in *Anodonta cygnea*.

There also seem to be conflicting ideas as to the direction in which the respiratory current proceeds, some contending that it invariably enters through the branchial orifice, and makes its exit through the anal one, others that it may proceed either in this or the reverse direction. I have taken some pains in investigating this subject, and have repeatedly tried experiments with the animals to find out the facts of the case; and the conclusion I have arrived at is, that, under ordinary circumstances, the current enters through the branchial opening, and issues through the anal one only. It may, however, in addition, enter at the anterior end or any intermediate point; but it never issues from any place other than the anal opening, excepting under peculiar circumstances, which I will presently mention, and then it is spasmodically. The ordinary position in which the animal is found is with the posterior end projecting from the mud which forms the sides and bottom of its habitat, the rest being imbedded in it. In this case, the direction of the current is the normal one; but should the animal choose to repose wholly uncovered by the mud, as not unfrequently happens, it then will separate the edges of the mantle from one another at some point, and through this the water flows also into it. Should, however, the branchial orifice from any cause become covered by sand or mud and the anal one remain free, it will then draw water in through the anal opening and expel it through the branchial one, causing the sand or mud to be blown away with very great violence, after which the normal state of affairs is resumed. This action is purely mechanical, the animal relaxing the adductor muscles, the valves gape, the opening, however, which would otherwise have been formed remaining closed by the thickened edges of the mantle being kept in contact; this causes the water to enter the anal orifice; then the valves are suddenly closed, and the water ejected through the branchial opening, the whole action being, in fact, exactly that of a pair of bellows. If both orifices are covered and there is water between the valves, they are brought together, and the branchial one freed, the anal one afterwards being uncovered by the ordinary action of the current. Any other point on the free margin of the shell may be uncovered in a similar manner. These facts I have tested by many trials, both with the Anodons and the Unios.

I remain, yours truly,
R. M. Lloyd.

8 Weston Road, Handsworth, Birmingham,
Dec. 9th, 1869.

On the Structure and mode of Growth of the Scales of Fishes. By Dr. Salbey.

The author has made some investigations upon the structure of the skin in fishes which must lead to great modifications in our ideas, especially of the construction and growth of the scales.

Fishes are generally sticky to the touch—a phenomenon which M. L. Agassiz ascribed to a mucosity secreted by peculiar glands. Leydig, however, showed that no mucus-gland exists at the surface of a fish. The so-called mucosity is, in fact, only the most superficial layer of the epidermis. In the terrestrial Vertebrata the most superficial layers of the epidermis become hardened to form the *stratum corneum* which scales off at the surface. In fishes the superficial cells of the epidermis, instead of hardening, absorb water, become softer and softer, and constitute the mucous covering of the surface, which is easily removed. The corium, placed immediately beneath the epidermis, is formed essentially of two crossed systems of connective bundles. It contains numerous pouches, in each of which a scale is lodged.

It is well known that the ctenoid and cycloid scales present numerous concentric striæ, which M. Agassiz interpreted as the margins of superposed layers forming the scale. This opinion, which is still generally accepted, is, however, quite erroneous, as has been clearly shown by Dr. Salbey by means of vertical sections. The striæ are due to a series of irregular crests, which all belong to the superficial layer of the scale. The deeper and much thicker layer is formed by a series of superposed lamellæ of two substances. The thickest lamellæ are colourless and brilliant; the thinner ones are yellowish and but slightly transparent; the former are calcareous, the latter are composed of a sort of cement destitute of lime-salts. The calcareous lamellæ being generally thicker in old individuals than in the young, it is probable that their increase in thickness is caused by a gradual incrustation of the interposed layers of cement. The growth of the scale is explained by the fact, that a deposit of calcareous salts is formed periodically in the part of the corium which is directly applied against the lower surface of the scale. This incrusted layer becomes for a time the lowest lamina of the scale. Then a layer of cement is deposited between this calcareous lamina and the corium: this alternate formation of calcareous and non-calcareous layers is repeated a great many times.

Besides the concentric lines, the scales present striæ which radiate from the centre to the periphery. These are the "longitudinal canals" of Mandl, the "fan-like furrows" of M. Agassiz, and the "sutures" of M. Peters. The name proposed by M. Agassiz (*sillons en éventail*) is perhaps the best, inasmuch as the striæ certainly correspond to furrows of the surface. But from the bottom of these furrows true partitions of unincrusted cement start, which traverse the whole thickness of the scale and divide it into a certain number of segments. By their partial incrustation these rays of cement may assist in the widening of the scale. At the centre of the system of concentric lines of the surface of the scale there is a region of peculiar appearance, which M. Agassiz designates the "centre of growth," and Mandl the "focus," by which he understands "focus of nutrition." M. Agassiz regards this region as the oldest portion of the scale, the layers of which have been worn away. As regards the first point, that of age, he is undoubtedly right; as regards the second, this is not the case. If the asperities are less prominent in this part of the scale, it is because they date from a period when the fish was smaller.—*Archiv für Anat. Phys. und wiss. Medizin*, 1868, p. 729; *Bibl. Univ.* November 15, 1869: *Bull. Sci.* pp. 276–278.

On the Anatomy of the Alcyonaria.
By MM. G. Pouchet and A. Myèvre.

The anatomical systems of most of the inferior animals have not even yet been clearly determined. The existence of distinct muscular elements in particular, long admitted upon the testimony of the movements which one sees executed by the animals, has only been demonstrated quite recently in the *Actiniæ* by M. Schwalbe. As to the Alcyonaria, M. C. Genth has indeed described the muscles of *Solenogorgia tubulosa*; but his description is very incomplete, and even it does not stand in any relation to what we have been able to make out of the muscles of two other Alcyonaria, *Alcyonium digitatum* and *A. palmatum*.

The muscular elements are pale fibres, soft during life, about 0·002 millim. in diameter when they are at the maximum of contraction, but usually much more slender. They are finely granular, without nuclei, and have distinct outlines. They may easily be isolated, at least in part of their length, which is variable. These muscular fibres are, by their appearance and size, very like those of the Nemertea. These fibres, in the Alcyonaria, are arranged sometimes in sheets, and sometimes in thicker or thinner bundles, which form true muscles, having sometimes very definite insertions, and needing to be described and named as so many primary organs.

1st. *Longitudinal Muscles.*—They are eight in number, and correspond to each of the mesenteroid laminæ, which they themselves assist to form. They extend from the peristome far into the cœnenchyma (*sarcosome* of M. Lacaze-Duthiers), which we find still very distinct upon the walls of the wide canal, which forms a continuation of the bodies of the polypes (*grossere Saft-Kanäle* of Kölliker).

2nd. This canal presents throughout, beneath the epithelium which lines it, a layer of circular or transverse fibres, covering and crossing at right angles the fibres of the longitudinal muscles lying against the substance of the cœnenchyma. These fibres, retaining their direction, give form to the mesenteroid laminæ; and they are to be found still, under the same conditions, even on the wall of the perigastric cavities.

3rd. *Sphincter.*—This muscle occupies the peristome. It is formed of eight portions, each nearly of a square form and corresponding to the base of a tentacle; the eight parts are separated by raphes, which are only the lines of insertion of the mesenteroid laminæ upon the peristome.

4th. *Tentacular muscles.*—Each partition separating the perigastric cavities gives origin above to two distinct muscles, which rise to the right and left into the two tentacles bordering upon the partition. Each tentacle thus receives two tentacular muscles, coming from the two septa bounding the perigastric cavity to which the tentacle corresponds. They ascend to the summit of the organ, approaching each other at a very acute angle.

5th. *Intertentacular muscle.*—In the angle formed by two neighbouring tentacles, we may clearly distinguish a muscular bundle which marks that angle and ascends on each side upon the borders of the two tentacles for nearly half their length.

These numerous muscles are inserted everywhere upon the fundamental substance of the animal, and in most cases are applied against it. This substance limits externally the body of each polype. It emits thin expansions, which serve above as a solid framework to the mesenteroid laminæ, bound the perigastric cavities, and are connected internally with another equally delicate lamina supporting the walls of the stomachal cavity. Externally this substance, whether upon the body of the polypes or between them, is nowhere covered with epithelium. It therefore remains in contact with the surrounding medium (like the bony tissue of the dermal plates of certain fishes). It follows from this, at least in this state of development of the Alcyonarian, that the fundamental substance does not correspond to the definition recently given of the so-called *conjunctive tissues*, which have been said to be "every tissue, with the exception of nerves or muscles, occurring between the external epithelial layer and the internal epithelial layer." This fundamental substance, both in the walls of the body of the polype and in the mass of the cœnenchyma, is everywhere identical.

It is fibrous in some places, and excavated by cavities of several kinds; and it is always in the midst of it, in places where it is perfectly homogeneous, that the spicules appear and become developed. Each polype is therefore in intimate relation of structure with the cœnenchyma by its constituent tissues. But the identity does not stop there, and we find it even in the tissues belonging to the group of products.

Throughout their length the wide canals are lined with the same vibratile epithelium, which is continued into the perigastric cavities, the tentacles, and the pinnules (*A. digitatum*). It is formed of spherical or slightly polyhedral cells of small dimensions. Those of the surface bear extremely delicate vibratile cilia, which appear to be but few upon each cell, and exhibit imperfectly rhythmical movements. The body of the cells appears to be formed of granulations enclosed in a hyaline substance. No nucleus is to be distinguished.

On the other hand, the epithelium which clothes the surface of the tentacles turned towards the mouth is not vibratile. It presents from place to place little projecting organs, about 0·025 millim. in length, sharp-pointed, slightly recurved, and endowed with no movement. Besides, this epithelium contains *nematocysts*, whilst there are none in the epithelium of the wide canals. But, on the other hand, their presence approximates the epithelium of the tentacles to the tissue which fills (but does not line, as has been stated) the small nutritive canals (*kleine Saft-Kanäle* of Kölliker). These canals are entirely filled up by a granular substance individualized here and there into cells. These cells are irregular, polyhedral by reciprocal pressure, accumulated in the canals. They are more finely granular and more transparent than those of the vibratile epithelium, and have a small nucleus of a rose-colour, with ill-defined although very distinct contours. We find among these cells (and consequently in the heart of the cœnenchyma) nematocysts exactly like those of the epithelium of the tentacles.

This peculiarity, in conjunction with the extension of the fundamental substance of the cœnenchyma into the polypes, and the extension of the muscles of the polypes into the heart of the cœnenchyma, establishes between them such an analogy of structure that it is not possible, in general anatomy, to distinguish them, or to find other than morphological differences between these parts.—*Comptes Rendus*, Nov. 22, 1869, tome lxix. pp. 1097–1099.

Observations on the Nasal Glands of Birds. By M. Jobert.

The secretory apparatus which occupies the greater part of the frontal region in birds, and which opens into the nasal fossæ, is more complex than has been supposed. It consists of two pairs of glands, closely applied to each other, but organically very distinct, and each having a distinct secretory duct: these two ducts run at first side by side; but in the nasal fossæ their course becomes very different, and their orifices are very wide apart. The author describes the structure of these glands and their anatomical relations. —*Comptes Rendus*, November 15, 1869, tome lxix. p. 1016.

On Remains of the Beaver in New Jersey. By Mason C. Weld.

I take the occasion of the recent discovery of a very interesting and novel fact to me to communicate with you. It is the finding of a genuine beaver-meadow on the very top and near the brink of the Palisades. The edge of the meadow is about 175 paces from the "steep rocks," which are, I suppose, about 500 feet above the tidewater in the Hudson river, and which rises so abruptly that a stone may in some places be thrown from the top into the water.

Stumps gnawed off by beavers were found by workmen getting out swamp-muck on the land of Mr. Charles Nordhoff, and in the rear of his residence. The trench in which they were found (6 or 7 feet below the surface) is about 10 feet deep; and though it was in the midst of the severest drought we had had for many years, water soon flowed into it. An eight-foot well on the place has contained a constant supply of water. An excavation made for a fish-pond, within ten rods of the steep rocks, filled up with water to the depth of two or three feet, without receiving a gill from rains or from the surface. Wells, springs, and brooks along the western slope and in the valley have gone dry in great numbers, while here and elsewhere along the top of the Palisades there has been an abundant supply. The beavers must have had permanent water. The size of the meadow is not more than four or five acres; the depth of the peat variable and uncertain; the bottom of the basin, where exposed, consists of a fine sandy hard-pan, with some small boulders and masses of trap; and the trap-rock in place is occasionally denuded.

To appearance there is an abundance of water along this whole range, which cannot be accounted for by the rainfall; and yet it is isolated by miles of intervening hills and valleys from equally high land. Permanent springs, little influenced by the season or by abundance or dearth of rain, are not rare on the western slope of the Palisades, and they are found on some of the highest points; one quite noted one is near Crum's Rock, the highest point.—*Silliman's American Journal*, November 1869.

Note on the Respiration of the Nymphæ of the Libellulæ. By M. Oustalet.

The author gives a very detailed description of all the parts of the tracheal system of these animals, and indicates the mode of termination of the aëriferous tubes in the branchial lamellæ with which the walls of the rectum are furnished. In these respiratory appendages the tracheæ form a multitude of capillary tubes arranged in loops, a mode of termination which has not previously been noticed.—*Comptes Rendus*, November 15, 1869, tome lxix. p. 1016.

The late Professor Michael Sars, *of Christiania.*

This eminent zoologist died on the 22nd of October last; and his loss will be much felt by all naturalists who have benefited, as I have done, by his long, laborious, and conscientious investigation of the invertebrate fauna of the Norwegian seas.

He was born on the 30th of August 1805, at Bergen, where his father was a shipowner. After finishing his academical studies at Christiania, and evincing at an early age his predilection for natural science, he entered into priest's orders, and in 1830 became pastor at Kinn, in the diocese of Bergen. Ten years afterwards he had charge of the parish of Manger in the same diocese. As both these parishes were on the sea-coast, Sars had constant opportunities of pursuing his zoological researches. In 1829 he published his first essay, entitled 'Bidrag til Söedyrenes Naturhistorie,' and in 1846 the first part of his celebrated work 'Fauna littoralis Norvegiæ.' In 1854 he was appointed Professor Extraordinarius of Zoology at the University of Christiania, a position which he filled up to the time of his lamented death with great honour to his country, and to the satisfaction of the whole world of science. His celebrity as a zoologist, as well as a palæontologist, was fully recognized by all naturalists and geologists, and he was elected a member of several foreign scientific societies. Our own distinguished countryman, the late Edward Forbes, individually showed his appreciation of Sars's labours in eloquent pages (66 and 67) of his own posthumous work, 'The Natural History of the European Seas,' when he said, "More complete or more valuable zoological researches than those of Sars have rarely been contributed to the science of Natural History; and the success with which he has prosecuted investigations claiming not only a high systematic value, but also a deep physiological import, is a wonderful evidence of the abundance of intellectual resources which genius can develope, however secluded and wherever its lot be cast;" and he added that the name of this Norwegian priest, "who reaped reputation when seeking no more than knowledge, familiar to every naturalist in Europe and America, in Asia, and at the Antipodes—for there are great naturalists settled far in the south, and many in the far east—is a sufficient proof that able work brings the rewards of applause and veneration, even when they be unasked for." By the observations of Sars on the development of the Medusæ he greatly advanced our knowledge of that remarkable physiological phenomenon known as the alternation of generations, which Chamisso had first indicated in the Salpæ. His last publication, 'Mémoire pour servir à la connaissance des Crinoïdes vivants,' excited especial interest, by showing that a race of animals, supposed to have been extinct for a period so long as only to be measured by the duration of several past geological epochs, occurred in a living state in the abysses of the Norwegian seas. This discovery mainly induced the recent exploration of our own seas at great depths, which has produced such wonderful results; and the living Crinoid, or "stone lily" (*Rhizocrinus Lofotensis*), has now been ascertained to inhabit many parts of the Atlantic from the Loffoden Isles to the Gulf of Mexico. The published works of Sars are seventy-four, and they are not less sound and valuable than numerous. One of his sons, Dr. George Ossian Sars, inherits the zoological inclinations and talent of the late Professor, and is second to none in the knowledge of the Sessile-eyed Crustacea.

It is exceedingly to be regretted that, in spite of the most rigid economy, the large family of Professor Sars is left in very impoverished circumstances, six of his children being wholly unprovided for. May I hope that naturalists and lovers of science will assist me in making a subscription for the temporary relief of this distressed family, and that they will by such tribute to his memory express their admiration of his career and services? I shall be very glad to receive any contributions.

J. Gwyn Jeffreys.

25 Devonshire Place, Portland Place, London,
21 December, 1869.

the spirit. The *Rhipiphorus* differs in size, but does not vary in size: this is not a distinction without a difference. There are two sizes; but these two are most constant. I have before me a series of about fifty of the smaller size taken out of the worker-cells, and they are as uniform in size as the workers of a hive of bees. The larger ones are scarcer, but all I have seen are of one size, too, and they all come from the female cells. All the little ones come from worker-cells, all the big ones from queen-cells, just as in the case of the wasps themselves, where all the little wasps come from the worker-cells, all the big ones (the queens) from the queen-cells; and to me this fact is a strong confirmation of the view that they must both be fed in the same way, viz. by the wasps. Whether, as in the case of bees, the wasps feed the tenants of the queen-cells with any special food, or use any special treatment by means of which the grubs in the queen-cells are developed into queens and those in drone-cells into drones, I believe is not known; but the presumption is in its favour. If it were mere increase of size that was produced, it might be said that it was due to more food and more space in which to grow; but more food should not alter the sex. The *Rhipiphorus*, not being a wasp, would appear not to be affected by the same influence, so far as regards sex; for I have a male from a queen's cell, but only benefited by it in the increase of its size; and it may be merely the effect of a longer continuance of feeding and a greater supply of food, as supposed by Mr. Smith; but then he will surely not carry his argument to the extreme of supposing that the mere difference between eating a worker-grub and a queen-grub is sufficient to account for the greater dimensions of the one in a queen's cell over the one in a worker's cell.

But there are other and not less serious difficulties in the way of Mr. Smith's hypothesis. The *Rhipiphorus*-grub is described as attacking the wasp-grub at the head, "the mouth of the former buried in the body of the latter just below the head." Of course it must begin at the head: it could not begin at the tail, which is out of sight at the base of the cell; and equally, of course, it must eat its way inwards head foremost. When it has completed its repast, by which time it is to attain its full size, its position must therefore necessarily be head inmost, and it must perforce pass its metamorphosis in that position; for the cell is too narrow for it to turn in; and it cannot back out, for the entrance is closed by the lid. But what is the fact in nature? Putting aside the exceptional cases of doubtful position in cells doubly occupied, the *Rhipiphori* have invariably their head to the mouth of the cell, exactly as the wasps, and fitting it as closely. This argument alone seems to me fatal to the hypothesis that the *Rhipiphorus*-larva limits itself to one victim.

The alternative hypothesis, by which it is supposed to feed on many, which I shall now consider, will be found to be no sounder. Supposing that the footless parasite larva roams about, emptying cell after cell, and clearing off wasp-grub after wasp-grub, and developing and increasing in the normal way at the expense of many, until the time approaches when it is to take its last meal and pass into the pupa state, it must by that time have attained considerable dimensions. A full-grown wasp-grub might indeed find room in its cell for a tiny *Rhipiphorus*-grub fresh out of the egg; but one about to pass into the pupa state, and nearly as big as itself, is another thing altogether. But might it not begin upon it with half or the whole of its body out of its victim's cell? No; because the cell has, by Mr. Smith's hypothesis, to be spun up by its victim; and it could not do this if the way were thus stopped, and, besides, it must not be so seriously injured or encroached on as to prevent its doing this. There is plainly no room to hold both. Two quarts of beer are not to be got into one quart bottle by any process hitherto found out. But Mr. Smith may abandon his lid-theory. He may admit the lid to be spun by the *Rhipiphorus*. But even then he has something else to get over. How is he to get the *Rhipiphorus*, which has entered the cell head foremost, turned round so as to have its head to the mouth of the cell? The creature, according to this theory, has the instinct of going head forward into the cells all the rest of its life. He must devise a new instinct for it to make it back out of the cell whose tenant it has eaten, and go on tail foremost into an empty cell when the proper time for it to back in comes. But if Mr. Smith admits all this—admits that the egg of the *Rhipiphorus* and of the wasp are the same and similarly placed, that the young larvæ of both are fed at first by the wasps, and that at last the mature larvæ of both spin the lids to their cells themselves—I think he must also admit that the whole of the abstract grounds on which the *Rhipiphorus* might be expected to have a different economy from that of the wasp is swept away. If it is admitted that it and the wasp do all the things that it seems unlikely they should do, there ceases to be any reason for denying that their economy is alike out and out, and that the same system of feeding by the wasps with which they commenced is continued to the end.

I shall now say a word or two as to Mr. Stone's observations: and here I may premise that, as will be evident to any one who compares Mr. Smith's quotations from them and my brief allusion to them in my former paper, I had not Mr. Stone's paper before me when I wrote. My purpose then was to record my own observations, not to attack Mr. Stone's; and as I could not lay my hands on his paper, I rested satisfied with a quotation as to the nature of its contents, which I received from my friend Mr. Pascoe. But now that I have read it all, I see nothing, with the exception of the one case which I have already questioned, which appears to me incapable of explanation, or, when rightly interpreted, irreconcilable with the views I hold or with the observations I made. His interpretation is of course irreconcilable, but not the facts themselves.

Mr. Stone only gives two actual cases of the alleged attacks of the *Rhipiphorus*-larva on the wasp-grub. He infers more, and Mr. Smith infers more, from his finding, as he thinks, "these creatures retaining the skin and mandibles of their victim in their grasp even after they have passed into the pupa state." I shall speak to that immediately—one thing at a time; but as to actual cases of this attack, the two given by Mr. Stone are the only two recorded by him or by any other person whatever. Of part of the first I have already, to a certain extent, suggested an explanation; but a portion of it remains which is very difficult of explanation. He opens the sealed lid of a cell in which should be a pupa, finds in it a wasp-larva with a minute *Rhipiphorus*-larva attached to it with its mouth firmly buried in the body of its victim just below the head; and it appeared to have only very recently fastened on its victim. May it not be possible that, in handling the nest and picking out the larvæ from the cells, Mr. Stone had inadvertently dropped this minute *Rhipiphorus* from his forceps into either this newly opened cell or another beside it which he confounded with it? If it fell upon a larva, of course there is nothing to be surprised at in its eating it, as the wasp-grub would have done with it if it had got the first chance. Both are admitted to be carnivorous; and that they should eat each other when they have the opportunity is only what might be expected. That those which I found living amicably together, two in the same cell, did not attack each other, was no doubt due to their having been brought up together and sufficiently fed otherwise. They were like the members of a young family of lions, which, although ready enough to carry death and destruction with them out of doors, live in peace and harmony at home. The fact that the little *Rhipiphorus* had only commenced its attack is, I think, in favour of this supposition. It is against all the rules of probability that the cell should have been opened at that precise conjuncture of time that it began its attack. It is also still more unlikely that, having been sealed up with it, it should not have sooner made its attack. It is so disrespectful to the instinct of the *Rhipiphori* that the parent should have laid an egg in a cell already tenanted, and within reach of the jaws of the tenant, that I shall not suggest that alternative.

As to the *Rhipiphorus*-pupæ retaining the skin and mandibles of the grub they have eaten in their grasp, which Mr. Stone alleges of this one and of others which he subsequently observed, it is obviously a somewhat ludicrous blunder arising from a confusion of head and tail. I presume that by retaining in their grasp, he means holding in their jaws; they have no legs or claws to grasp with. But he must have forgotten that the parasite began at the head and, of course, finished off at the tail, and that it therefore should not be the mandibles that "it retained in its grasp," but the other end. But it seems to me clear that he had observed the old cast skin of the larva, which lies at the bottom of the cell, sticking to the tail of the pupa, not retained in its mouth. We know that the tail forms a powerful sucker; and, of course, it sucks up into its cup, like the bottom of a seaman's lead, anything that is lying loose at the bottom; and we know, too, that the last cast skin of a larva is very often found adhering to the chrysalis. We know, also, that when the larva undergoes its transformation, its muscles undergo a complete degradation, becoming like milk, and all muscular power on the part of the pupa at that particular period vanishes. As the change goes on, the muscular power is restored by the re-formation or consolidation of the muscles; but the idea of a pupa holding anything in its jaws by the tenacity of its muscular power seems to me an impossibility. I have only to add that none of my pupæ (and I have a number preserved in Canada balsam) has either skin or mandibles in its jaws, but most of them have them still adhering to the tail. This fact seems to prove that, like my pupæ, Mr. Stone's must have had their heads to the mouth of the cell, instead of in the position which his and Mr. Smith's hypothesis requires, at its base.

Next, as to the second and only other case of a *Rhipiphorus*-larva taken in the act of attacking a wasp-grub. The statement is as follows:—"I was fortunate in discovering a small larva of *Rhipiphorus* firmly attached to its victim; both were dead, and had become partially dried, so that, when immersed in spirits, they did not separate, but remained attached just as they were before death."

This seems to me to be a case of a double occupation of one cell, similar to those which came under my notice; and the attachment of the one to the other is probably nothing more than what may be seen in every bottle of insects sent home from abroad or collected at home: some of the dying insects in their mortal agony have seized the nearest object with their mandibles, and arrive with a leg or some other part of their neighbour's body in their mouth, still firmly clasped in the death grip,—that is, supposing that the jaws of the one really are fastened in the body of the other. It may be only a mutual adhesion by lesion of the skin in the process of decay or drying up. I hope to see the specimen in Mr. Smith's hands before this goes to press; and if I do, and it contains any information, I will mention it in a postscript.

P.S. Since writing the above, I have seen the specimen in Mr. Smith's possession, and find it presenting almost exactly the same appearance as the specimen which I have above alluded to and which I have placed in the Collection of Economic Entomology in South-Kensington Museum. There are no means of saying whether the larvæ are merely in juxtaposition or if one has its jaws fastened on the other; but both are well grown, and except where they touch each other (where there is some lesion) they are uninjured. I have no doubt it is a case of double occupation of one cell, of the same nature as those described by me, and that, if the lesion (which I attribute to the pressure of the one upon the other) is not so great as to have destroyed the parts, Mr. Smith, on separating them, would find that they were not fastened to each other at all.

I had also the pleasure of showing to Mr. Smith my specimens of pupæ with the cast skin still sticking to their tail; and I think he will no longer regard Mr. Stone's observation of these cast skins as proof "of these creatures retaining the skin and mandibles of their victims in their grasp," nor as additional observed instances of the attack of the wasp-grub by *Rhipiphorus*-larvæ. As I stated at the outset, these observed instances are reduced, nominally, to two, but really only to one,—one of the two being that above mentioned, which I maintain is not an instance of attack at all, but of double occupation of cell; and the other, of actual devouring, which I have endeavoured to account for, but which, whether my explanation be the true one or not, is, I feel perfectly convinced, not to be regarded as a genuine normal example of the habits of the animal, but as arising from some error of observation.

XII.—*Additions to the* Tenebrionidæ *of Australia &c.* By Francis P. Pascoe, F.L.S., F.Z.S., &c.

The following additions to the list of Australian Tenebrionidæ are mostly derived from a select collection sent me by Mr. George Masters, who has lately been collecting in Queensland and in Western Australia. The value of the collection was greatly increased by notes of the habits or other particulars of the species composing it. Among the three or four new genera here described, the most interesting perhaps is one belonging to Bolitophaginæ (*Mychestes*), which frequents rotten wood in which probably some minute fungus has made its appearance. A few species remain for further investigation, some not being in sufficiently good condition for description. In the collection, but not belonging to the Tenebrionidæ or even to the Heteromera, was a remarkable new form*, apparently of Monotomidæ, found in ants' nests,—also examples of Erichson's curious genus *Ancistria*, hitherto known only from India, and of which no species occurred in the wonderfully rich collections made by Mr. Wallace in the intervening Malayan islands.

Scymena† *amphibia.*

S. ovalis, pallide testacea, subnitida; scutello valde transverso; elytris sulcato-punctatis, punctis minutis.

Hab. King George's Sound (sea-shore, burrowing in the sand).

Oval, moderately convex, pale testaceous, slightly nitid; head finely punctured, line of separation between the clypeus and front not sharply defined, but of a darker colour; antennæ nearly as long as the breadth of the head, the outer joints slightly moniliform; prothorax rather finely punctured, the apex very slightly emarginate; scutellum very transverse; elytra sulcate-punctate, the punctures small, placed in shallow grooves, the intervals very minutely, almost obsoletely punctured; tibiæ and tarsi roughly ciliated, the latter somewhat slender. Length 3 lines.

In general appearance this species closely resembles the common *Phaleria cadaverina* of our southern coasts, and probably, like it, preys on dead animal substances when it has the opportunity. Mr. Masters says that it is found "burrow-

* Since this was written, I have seen reason to believe that this is the insect described by the Count of Castelnau, in the Rev. et Mag. de Zoologie for September, p. 356, under the name of *Nepharis alata*. It is referred to the Colydiidæ, and "perhaps near *Cossyphodes*," and figures are given (pl. 18. figs. 4, 5). The two specimens in the Count's possession were very imperfect.

† Pascoe, Journ. of Entom. ii. p. 455.

ing in the sand, generally above, but often below, high-water mark." *Scymena* differs *inter alia* from *Phaleria* in its deeply emarginate clypeus. As the genera of the Trachyscelinæ to which it belongs have been much increased since M. Lacordaire's volume on the Heteromera was published, the following table may be useful:—

- Antennæ eleven-jointed.
  - Antennæ longer than the head.
    - Prothorax closely applied to the elytra.
      - Elytra ciliated at the margins .... *Ecripsis*, Pasc.
      - Elytra not ciliated at the margins .... *Phaleria*, Latr.
    - Prothorax not closely applied to the elytra .... *Ilyocis*, Pasc.
  - Antennæ shorter than the head.
    - Anterior tarsi retractile.
      - Intermediate and posterior tarsi elongate, filiform.................................. *Isarida*, Pasc.
      - Intermediate and posterior tarsi short, stout.. *Ammobius*, Guér.
    - Anterior tarsi not retractile.
      - Antennæ with an abrupt three-jointed club .. *Chœrodes*, White.
      - Antennæ gradually stouter outwards.
        - Clypeus deeply emarginate .... *Scymena*, Pasc.
        - Clypeus entire anteriorly.
          - Last tarsal joint as long as the rest together .... *Ammidium*, Er.
          - Last tarsal joint shorter than the rest together.
            - Posterior tarsi filiform, elongate ...... *Emypsara*, Pasc.
            - Posterior tarsi short, stout.
              - Last joint of maxillary palpi securiform.......................... *Sphargeris*, Pasc.
              - Last joint of maxillary palpi fusiform *Anemia**, Casteln.
- Antennæ ten-jointed.......................... *Trachyscelis*†, Latr.

Byrsax‡ *saccharatus.*

B. oblongo-quadratus, indumento albescente tectus; prothorace utrinque antice explanato, postice eroso, disco supra valde gibboso producto; elytris grosse tuberculatis.

Hab. Queensland (Pine Mountain, near Ipswich, in a *Boletus*).

Oblong-quadrate, covered above with a thick spongy-look-

* This genus, founded on an African (Senegal) insect, I have not seen; its place here may be somewhat doubtful. M. Lacordaire unites it, erroneously, with *Ammidium* (Gen. v. p. 725). A rare European insect (*A. sardoa*) is referred to it.

† M. Duval is the only author who has given the correct number of antennal joints in this genus (Gen. Col. d'Eur. iii. p. 288). In reference to his figure (pl. 71. fig. 352 *b*), I have failed to detect the moniliform structure of the club, and the basal joint is much larger and curved almost at a right angle. It must be recollected, however, that the whole antenna is not larger than the point of a fine needle.

‡ Pascoe, Journ. of Ent. i. p. 42.

ing whitish substance; head deeply sunk in the prothorax, the anterior portion spreading into two shortly triangular horns; prothorax with a very compressed disk, forming an oblique elevated tuberculate lobe, extending over the head, behind which are two erect well-marked conical tubercles, each side anteriorly expanding into a fan-shaped, strongly crenated margin, but posteriorly deeply and erosely emarginate, so as to present a large and irregular space between these fan-shaped expansions and the elytra; scutellum apparently large and triangular, but its limits indistinct; elytra nearly quadrate, the whole surface more or less tuberculate; the disk almost vertically elevated, with two conical tubercles at the base on each side, and towards the suture a line composed of four or five large triangular tubercles, the last being by far the largest; a row of six smaller tubercles externally on the descending side of the disk, the margin moderately expanded and regularly and coarsely crenato-tuberculate, the apical tubercle diverging slightly from its fellow; body beneath covered with a layer of the same spongy-looking substance as that above mentioned, but thinner; legs ferruginous, with a sprinkling of the same substance; antennæ with the last three joints forming a distinct club. Length 2½ lines.

A remarkable and very distinct species, which I hope to figure in a future communication, with further remarks on this and other members of its subfamily, including the following new genus.

Mychestes.

(Subfamily *Bolitophaginæ*.)

Antennæ clavatæ, 10-articulatæ; clava biarticulata.
Tibiæ anticæ subfusiformes.
Elytra ovata; *metasternum* breviusculum.

Head broadly transverse, the clypeus not cornuted; antennary ridge simple. Eyes transverse, entire. Antennæ clavate, 10-jointed; scape elongate, the third joint as long as the scape, the rest to the eighth oblong ovate, the last two forming an ovate club. Prothorax transverse, rounded but not expanded into a border at the sides; the disk gibbous towards the apex, overhanging and concealing the head from above. Elytra ovate, convex, closely applied to the prothorax; the epipleuræ indeterminate. Legs moderate; femora not thickened; tibiæ subfusiform, scarcely compressed; tarsi with the terminal joint as long, or nearly as long, as the rest together. Pro- and mesosterna simple. Metasternum short.

This genus differs from *Orcopagia* (*ante*, vol. iii. p. 30) chiefly in the form of the elytra and in the short metasternum, the latter character being an exceptional one in its subfamily. The female apparently only differs from the male in being broader and more bulky.

Mychestes lignarius.

M. fuscus vel fusco-ferrugineus, squamulis pallidioribus dispersis, supra fortiter tuberculatus.

Hab. Queensland (in rotten wood).

Dark brown or ferruginous brown, covered with loosely set small paler scales, and strongly tuberculate above; antennary ridge convex anteriorly; clypeus truncate, its junction with the head forming a broad deep groove; prothorax broader than the elytra, much rounded and bituberculate at the sides; the disk with a double row, slightly arched forwards, each of four tubercles; scutellum rounded, prominent; elytra ovate, raised at the sides, somewhat flattish above, each with a row of three large tubercles not contiguous to the suture, with a fourth but smaller tubercle in the same line behind, and at the sides seven nearly as large and irregularly arranged in two rows; legs somewhat hispid, the claws ferruginous; antennæ slightly setulose, the third joint as long as the two next together. Length 4 lines.

Isostira.

(Subfamily *Opatrinæ*.)

Clypeus apice integer; *labrum* transversum, haud sinuatum.
Palpi maxillarum securiformes.
Prothorax elytris arcte aptatus.
Epipleuræ elytrorum posticæ deficientes.

Of this genus I have only a single specimen, and, as the males (and commonly the females) of the Opatrinæ have mostly dilated anterior tibiæ, whilst this has them of the ordinary form, it is possibly a female; or the character may be common to both sexes. The genus, however, allied to *Opatrum*, Fab., in the last three characters of the above diagnosis, is essentially differentiated by the clypeus and upper lip. The antennæ are rather short, the last six joints moniliform, forming a tolerably distinct club; of these the seventh to the tenth are very transverse; the labial palpi arise from the central portion of the labium, and not from its base as in *Opatrum* (*O. sabulosum*). The prothorax is more convex and overhangs the head, and is closely applied to the elytra. All the tibiæ are subfusiform or a little contracted at the extremity. The tarsi are slender and villous beneath.

Isostira crenata.

I. supra nigra, infra rufo-castanea; antennis pedibusque rufis; prothorace lateraliter crenato; elytris acute costatis.

Hab. Queensland (under bark of decaying trees).

Oblong, black above; head vertical, rather finely and closely punctured; eyes nearly entire; prothorax covered with a dull brownish exudation, its sides distinctly crenated, the disk raised and having anteriorly two short strongly elevated lines or ridges; scutellum rounded behind, indistinct; elytra glossy black (from abrasion?), each with five narrow sharply elevated ridges and a prominent line at the margin separating the epipleura from the upper portion, intervals of the ridges with two lines of shallow foveæ; body beneath reddish chestnut; legs and antennæ pale reddish. Length 3 lines.

Omolipus cyaneus.*

O. supra cyaneus, nitidus, infra fusco-castaneus, antennis pedibusque rufis glaberrimis; elytris fortiter seriatim et confertim punctatis.

Hab. Nicol Bay.

Very dark glossy blue above; head and prothorax very smooth and finely punctured; the latter a little gibbous anteriorly, the sides well rounded, the base and apex of nearly equal breadth; scutellum triangular; elytra rather narrowly ovate, strongly seriate-punctate, the punctures approximate, the intervals of the lines very narrow and convex; body beneath brownish chestnut, very glabrous; legs and antennæ reddish, smooth. Length $4\frac{1}{2}$ lines.

Mr. Masters also finds this species at King George's Sound, under the bark of growing trees. It is at present the only one known not entirely black above.

Pterohelæus† arcanus.

P. latissime ovatus, brunneo-piceus, paulo nitidus; elytris singulatim unicostatis, lineisque subelevatis granulatis instructis, marginibus late foliaceis.

Hab. Queensland (Port Denison, under bark of living trees).

Broadly ovate, brownish pitchy, slightly nitid; head impunctate; the clypeus, marked off by a fine line, broad and rounded anteriorly; prothorax very short, deeply and narrowly emarginate at the apex, the middle of the disk with two conspicuous foveæ; scutellum transversely triangular; elytra moderately convex, with broad foliaceous margins raised and thickened at their edges, each elytron with a glossy elevated

* Pascoe, Journ. of Ent. i. p. 127.

† De Brême, Essai &c. p. 27.

ridge or line near the suture, terminating posteriorly in a number of small granules, a series of about six more or less elevated longitudinal lines, dotted with granules, on the rest of the elytron, one of these between the suture, which is also marked by a similar line, and the ridge, the remainder, of which the second and fourth are the most prominent, externally, the intervals of the lines minutely punctured in two rows; body beneath and legs glossy chestnut-brown. Length 9 lines.

Broader than *P. piceus*, Kirby, and strongly differentiated from every other species by the sculpture of its elytra.

Pteroheleus asellus.

P. ovalis, utrinque paulo incurvatus, fuscus, vix nitidus; prothorace obsolete punctato; elytris lineatim leviter punctatis, marginibus latitudine omnino æqualibus.

Hab. Queensland (under bark of fallen trees).

Oval, the outline equally rounded and rather obtuse at both extremities, the sides a little incurved, moderately convex, blackish brown, scarcely shining; head and prothorax covered with exceedingly minute punctures, the margins of the latter gradually passing into the disk; scutellum transversely and curvilinearly triangular; elytra linearly punctured, the punctures rather small, the fifth and eighth intervals between the lines a little broader than the rest, the margins concolorous, narrow, of equal breadth throughout, and agreeing with those of the prothorax; body beneath and legs glossy brown; antennæ short, the last joint nearly circular. Length $4\frac{1}{2}$–5 lines.

Resembles *P. peltatus*, De Br., but much more convex, nearly opaque, the margins of the prothorax and elytra much narrower and concolorous with the rest of the upper surface.

Helæus Mastersii.*

H. late obovatus, fuscus, squamositate grisea tenuiter tectus, setulisque erectis nigris instructus, in utroque elytro carina acute elevata, apicem haud attingens.

Hab. Western Australia (Salt River, under stones).

Broadly obovate, dark brown, covered with a loose greyish dust-like squamosity and furnished above with short erect black bristles; eyes approximate, nearly covered by the prothorax; the latter impunctate, nearly semicircular, not narrowed at the base, the margin broad, slightly concave, the centre with a narrow very distinct longitudinal ridge not quite extending to the base; scutellum transverse; elytra as broad at

* Latreille, Règ. An. ed. 1, iii. p. 301.

the base as long, broadest behind the middle, sides of the disk very convex, the margins moderately foliaceous, irregularly punctured, the intervals of the punctures with short bristles, the suture finely raised, and at a short distance on each side of it a strong carina not reaching to the apex, another, but nearly obsolete, at the same distance on the outer side; body beneath and legs dull brown, the latter especially covered with short hairs. Length $6\frac{1}{2}$–$7\frac{1}{2}$ lines.

Allied in form to *H. Peronii*, De Brême (Boisd.?), which, however, is a perfectly glabrous species, except as to the legs.

*Saragus** *floccosus.*

S. late ovatus, fulvo-testaceus, subtiliter punctulatus; prothorace apice profunde et anguste emarginato; elytris haud carinatis, sutura elevata.

Hab. Queensland (Wide Bay, on trees; Brisbane, &c.).

Broadly ovate, moderately convex, fulvous testaceous, minutely punctulate; head small, eyes nearly contiguous; antennæ ferruginous; prothorax short, very transverse, brownish testaceous, the apex narrowly and deeply emarginate; elytra not carinate, the suture raised, the expanded margins rather narrow; body beneath and legs dark brown, shining; margins of the elytra beneath broad, glossy testaceous, minutely punctulate. Length 6 lines.

All the specimens I have seen of this insect have been covered with a close-set white flocculent substance, which Mr. Currey, than whom there could be no higher authority, considered to be a fungus belonging to the genus *Isaria* of Persoon, supposed to be the early condition of the Sphæriæ. This *Saragus*, Mr. Masters writes, is found "on trees covered with a white lichen which the insects very much resemble."

Saragus patelliformis.

S. subrotundatus, depressus, fuscus, fere glaber; prothorace in medio excavato; elytris tenuiter punctatis, indeterminate costulatis, sutura anguste elevata.

Hab. Western Australia.

Nearly round, depressed, blackish brown, somewhat shining, and nearly glabrous; head small, finely punctured, the intervals of the punctures granuliform; prothorax finely punctured, the disk narrow, with a well-marked central impression, each of the dilated margins as broad as the disk; scutellum very transversely triangular; elytra rather finely but irregularly

* Erichson, Wiegm. Arch. 1842, i. p. 171.

punctured, indistinctly ribbed, the suture raised into a finely marked narrow carina; body beneath dull black, the margins of the elytra glossy; legs slightly hairy. Length 4–5 lines.

A depressed form allied to *S. Duboulaii*, Pasc., but, *inter alia*, with a very distinctly elevated suture.

Saragus incisus.

S. obovatus, fuscus, opacus, postice convexior; prothorace lobo gibboso postice angulato-emarginato; elytris singulatim unicostatis, extus triseriatim tuberculatis.

Hab. New South Wales (Mudgee, under stones).

Obovate, dark brown, opaque; head and prothorax covered with short minute ridges (except the centre of the latter), and more or less longitudinal or slightly oblique; eyes not approximate, front rather concave; prothorax deeply emarginate at the apex, the angles on each side produced, subacute, behind the middle a slightly gibbous lobe angularly emarginate posteriorly; scutellum broad, rounded behind; elytra gradually broader behind for about two-thirds of their length, the suture finely raised, each elytron with a stout costa near the suture, abruptly terminating near the commencement of the posterior declivity, the space between the two irregularly but finely punctured, between the costa and expanded margin three rows of small elevated tubercles; body beneath and legs black, rather glossy. Length 10 lines.

A very distinct species, approaching, but only to a limited extent, *S. lævicollis*, Fab., and its allies.

Saragus asperipes.

S. breviusculus, obovatus, fusco-niger, opacus; elytris lineatim subtiliter punctatis, marginibus angustis, haud corrugatis; tibiis tuberculato-hispidis.

Hab. South Australia (Port Lincoln, under stones).

Rather shortly obovate, brownish black, opaque; clypeus slightly emarginate; head and prothorax finely but not closely punctured, the latter with the disk slightly convex, distinctly separated from the margins, and of a paler brown, raised and thickened at the edges; scutellum broadly transverse; elytra more convex posteriorly, finely punctured in slightly irregular lines, every fourth interval between the lines slightly elevated, the margins very narrow and gradually obliterated posteriorly, not marked with transverse folds; body beneath and legs brown, slightly nitid; tibiæ covered with small hispid tubercles; tarsi yellowish ferruginous; antennæ with the last joint nearly circular. Length 5–6 lines.

Allied to *S. simplex**, Hope, but shorter and more convex, with a narrow margin to the elytra, and hispid tibiæ. The former species has the elytral margins marked with delicate transverse folds.

Saragus confirmatus.

S. obovatus, niger, subopacus; elytris singulatim quadricostatis, costis apicem versus evanescentibus, marginibus obsoletis.

Hab. West Australia (Mr. Duboulay).

Rather broadly obovate, black, slightly opaque; head finely punctured, broad in front, the clypeus not emarginate; prothorax very minutely punctured, the disk slightly convex, distinctly separated from the margins, which are unicolorous and not thickened at the edges; scutellum broadly transverse; elytra more convex posteriorly, impunctate, but closely covered with minute granules, each with four elevated lines gradually disappearing posteriorly, the first and third strongly marked, the fourth nearly obsolete, the suture raised, the margins not dilated, except very slightly at the anterior angles, and forming a narrow elevated edge; body beneath and femora brownish black, finely punctured; tibiæ minutely spinulous; tarsi slightly ferruginous; antennæ blackish, the last joint nearly circular, ferruginous. Length 6 lines.

Narrower than the last (*asperipes*), but at the first glance somewhat similar; it is, however, a very distinct species, and the elytra are totally destitute of dilated or foliaceous margins; but there is such a gradual approach to this in some other species as almost to take its absence out of the category of generic characters.

Adelium† *geminatum.*

A. fusco-cupreum, subnitidum; prothorace pone medium valde incurvato, supra canaliculato; elytris interrupte striatis.

Hab. Queensland (Wide Bay, under logs in dense scrubs).

Dark copper-brown, faintly nitid; head finely and irregularly punctured, the clypeus narrow anteriorly and rather strongly emarginate; prothorax transverse, irregular above, finely and unequally punctured, with a slender longitudinal groove, the sides strongly rounded, and behind the middle deeply incurved and terminating in a sharp angle; elytra broader than the prothorax, subovate, rounded at the shoulders, interruptedly striate, the alternate intervals of the dorsal

* This species appears to me to be the same as *S. carinatus*, De Br., of which possibly *S. silphoides* of the same authority is only a variety.

† Kirby, Trans. Linn. Soc. xii. p. 420.

striæ rather broader than the others; body beneath and legs dark copper, the former nearly glabrous, the latter with a few scattered hairs. Length 5–6 lines.

In outline approaching *A. cisteloides*, Er., and its allies; but the form of the prothorax and the rather peculiar sculpture of the elytra make it a very distinct species.

Licinoma elata.*

L. cuprea, nitida; elytris profunde punctato-striatis; tarsis longiusculis, fulvis.

Hab. Queensland (Wide Bay, under logs and stones).

Copper-brown, shining, and finely punctured as in *L. nitida* (*ante*, ser. 4. vol. iii. p. 140), but longer, the prothorax more rounded at the sides, considerably narrower, and much more finely punctured above; scutellum distinct and triangular; elytra deeply sulcate, the interstices narrow, but very convex and finely punctured, the punctures continued to the sulci, but scarcely apparent in the sulci themselves; the most trenchant difference is that the anterior tarsi in both sexes have not the second and third joints short and transverse, as in my specimens of *L. nitida*, but triangular, shortly so in one, probably the male, and longer and ovate in the others: in the typical form of the genus the claw-joint is nearly as long as the rest together, while in the present species the four basal joints are together half as long again as the claw-joint; in both the joints of the antennæ are connected by short peduncles (or moniliform). Length 5 lines.

Dinoria† cœlioides.

D. cuprea, nitida; elytris sat late punctato-striatis, marginibus concoloribus.

Hab. Queensland.

Copper-brown, shining; head rather finely and distantly punctured; the clypeus concave in the middle, the suture straight; prothorax transverse, finely punctured; scutellum very transverse, short, indistinct; elytra obovate, rather finely punctate-striate, the intervals between the striæ not approximate, flattish, very delicately punctured, the margins and apex concolorous; body beneath very glossy, reddish chestnut; legs yellowish testaceous, the bases of the femora chestnut; palpi and antennæ pale ferruginous, the last joint of the latter broadly oval, much shorter than the two preceding together. Length $2\frac{3}{4}$ lines.

* Pascoe, Ann. & Mag. Nat. Hist. ser. 4. vol. iii. p. 140.

† Pascoe, *ibid.* p. 141.

More convex than *D. picta*, and the eyes not quite so round. The scutellum of the latter was, from some oversight, stated to be "narrowly," instead of broadly, triangular, but it is not so transverse, although much more distinct than in the present species.

Seirotrana Mastersii.*

S. oblonga, cupreo-metallica; prothorace subplanato, marginibus integris; elytris ovatis, lineis interruptis elevatis, interstitiis biseriatim sub- vage punctatis.

Hab. Queensland (Wide Bay, under logs in dense scrubs).

Oblong, shining metallic copper; head roughly punctured, the clypeus broad, truncate anteriorly; prothorax nearly flat above, minutely punctured, with a few much larger punctiform impressions irregularly scattered, the sides rounded, but a little incurved towards the base, the margins with a raised linear border; scutellum transversely triangular; elytra slightly convex, ovate, each with four raised interrupted lines, the intervals between them biseriately punctured, the punctures rather small and not approximate; body beneath and legs glabrous, brassy, and very glossy. Length 9 lines.

A fine and very distinct species, with the sculpture of the elytra like that of *S. catenulata*.

Seirotrana nosodermoides.

S. subplanata, fusca, indumento umbrino dense tecta; prothorace lato, apice profunde emarginato, utrinque crenato; elytris interrupte costulatis.

Hab. Queensland (Wide Bay, under logs).

Rather flattish above, dark brown, covered with a dense umber-brown scaly crust, readily peeling off; head roughly impressed, a stout ridge on each side in front of the eye, meeting on the vertex, and forming with the clypeus a triangular space; prothorax longer than broad, the disk with five broadly impressed longitudinal grooves, the apex widely and deeply emarginate, the anterior angles produced, passing beyond the eyes, the sides coarsely crenated, and forming an obtuse angle at the middle, then slightly incurved to the base; scutellum semicircular; elytra ovate, each with five interrupted elevated lines, alternating with finer lines of the same character, the inner nearly contiguous to the suture, the intermediate spaces irregularly punctured; body beneath with an easily displaced reddish-brown crust; the legs with scattered adpressed hairs. Length 6 lines.

* Pascoe, Journ. of Entom. vol. ii. p. 483.

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X.—*Note on the Sponges* Grayella, Osculina, *and* Cliona. By H. J. Carter, F.R.S. &c.

At the suggestion of my kind friend Dr. J. E. Gray I have examined Schmidt's *Osculina polystomella* and some living species of *Cliona*, for the purpose of ascertaining how far these sponges were allied to *Grayella cyathophora* (which I described and figured in the 'Annals,' ser. 4. vol. iv. p. 189, Sept. 1869), with the following results.

And first as regards *Osculina polystomella* (Schmidt's 'Sponges from Algiers,' 1868, second Suppl. to 'Sponges of the Adriatic Sea,' 1862, pl. 1. figs. 1–13), it must be premised that this sponge was examined by the able author after preservation in spirit, and that Lacaze-Duthiers, who contributed the specimen, furnished also figs. 1–8 of the illustrations.

At first sight of the plate, one is inclined to say that this sponge is closely allied to *Grayella*, except that fig. 1, which is stated to represent its natural size, far exceeds *Grayella cyathophora* in the dimensions of its papillary elevations. Lacaze-Duthiers's fig. 2 would represent the mammilliform vent, and figs. 3–7 the papilliform sieve-like orifices of the inhalant area, together with (fig. 8) their sarcodal columns and projecting spicules, in both *Grayella* and *Osculina*. But when we come to Schmidt's description, then also comes a discrepancy, viz. that *all* these papilliform figures are stated to be excurrent orifices; and the only example of an incurrent or inhalant set is that in Schmidt's fig. 11, where a few little apertures are situated on one side of the disk of a papilla marginated, but apparently unfringed, from contraction at or after death.

It seems very probable to me, after the examination of *Cliona northumbrica*, Hancock, which I have just made (for this is the *living* species that I have had under observation), that Lacaze-Duthiers's figures (viz. 1–8, which are the principal illustrations to Schmidt's description) were made during life, and that Schmidt's own (viz. 9–13 inclusive) have the contracted forms presented to Schmidt in the preserved specimen.

Although Schmidt's section of the two papillæ (fig. 12), representing the sarcodal columns in connexion respectively with large canals below them, while the latter, again, are stated to open on the surface by several little orifices between the columns (that is to say, sieve-like), is exactly like the structure of the papilliform inhalant area of *Grayella* (see my figures, *l. c.*), yet in fig. 11 Schmidt represents an osculum, or large excretory orifice, in the centre of the marginated disk of a papilla, in addition to the sieve-like group of little pores close to the margin. If Schmidt be right in considering this an osculum and the group of smaller apertures "inhalant pores," then we must infer that the osculum is in connexion with its own excretory canal, and that the pores have their own inhalant canals or canal beside it, in which case this is an instance of the combination in one papilla of both organs, viz. the excurrent and incurrent system of canals respectively—a possible combination which I do not deny, but of which I have seen no example either in *Grayella* or *Cliona*.

I say "if right," because Schmidt's observations having been made on a preserved specimen, his distinction of excurrent and incurrent apertures must be made from resemblances, as, I think, is stated in his description.

Now, if Lacaze-Duthiers's fig. 8, representing a mammilliform eminence terminated by a single large orifice, be viewed as an excurrent organ, and the fringed papillæ respectively with their sieve-like orifices as inhalant areæ, then the analogy between *Grayella* and *Osculina* becomes very strong. But in Schmidt's description, as before stated, they are all alike regarded as excretory; there is no part illustrative of the great inhalant system but the little insignificant group of orifices placed on one side of the disk of a papilla otherwise devoted to the excretory system, as above mentioned.

My impression of such orifices is that, for the most part, excretory openings are large, single, and simple, and that it is the oral ones which are tentaculated, fringed, or otherwise ornamented with useful appendages. In *Actinia* and *Hydra*, where there is but one orifice for both purposes, it is ornamented; but certainly in the Polyzoa and Ascidiæ, where there are two, it is the oral, and not the anal, orifice which is thus complicated. Hence, from analogy, I should be inclined to think that the fimbriated papillæ of *Osculina* were the inhalant, and the less ornamented curticonical ones, with large single apertures respectively, the excretory organs. So, "at first sight of the plate," as above stated, *Grayella* and *Osculina* appeared to me to be very closely allied.

Let us now see how far the study of *Cliona* in a living state assists us through these difficulties.

On the 6th December, 1869, after a storm, I picked up on the beach at this place (Budleigh-Salterton, Devon) a specimen of *Laminaria*, in the inner and vaulted portion of whose conical bunch of roots was fixed a small oyster-shell permeated by a species of *Cliona*, which subsequent examination proved to be that so faithfully described and figured by Mr. Albany Hancock as *Cliona northumbrica*, in the 'Annals,' ser. 3. vol. xix. p. 237, pl. 7. fig. 1, April 1867.

The shell in which the specimen was situated, having been released from the roots of the seaweed, was immediately placed in sea-water (renewed daily) and examined for eight days successively. It was about two inches in diameter, and originally fixed obliquely upwards among the roots of the *Laminaria*, some small ones of which were attached to its outer or convex side, while the inner or concave part of the shell was free from all root-attachment and faced the hollow part of the coniform root-bunch. No doubt the *Laminaria* had been attached by its other roots to a rock but trusting too much to the surface of the otherwise unfixed oyster-shell led to its being torn from its site by the waves, and thus thrown upon the shore where I found it.

There were twelve papillæ of different sizes scattered over the convex part of the shell, among the attachments of the roots of the *Laminaria* (which were all cut off short for better observation), and the same number on the concave surface or that directed towards the hollow cone of the root-bunch. Six of the latter were papilliform vents presenting respectively a more or less elongated conical form, truncated at the extremity and provided with a single large circular aperture, circumscribed, when fully extended, by a delicate thin margin. The rest of the papillæ on both sides were more or less expanded, or obversely conical, presenting a fimbriated surface radiating more or less from the centre, in which were irregularly scattered a few small circular orifices varying and less than 1-600th of an inch in diameter.

The fimbriated surface consisted of feather-like extensions based on groups or bundles of pin-like spicules pointed outwardly, which, issuing with the soft sponge-substance of the papilla, were thrown apart as the sarcode raised itself upwards out of the circular hole in the oyster-shell, and thus, opening flower-like to the water, disclosed at the same time those beautiful feather-like appendages of the circumference, together with the minute pores of the centre, for inhalation.

The form of the vents, too, if anything, when fully expanded, tended to a trumpet-shaped opening; but the margin of all the orifices, both inhalant and excurrent, was minutely serrated by the projection of the pointed ends of spicules tied or webbed together by transparent sarcode, in which the denser parts, hanging about the thrown-aside spicules of the bundle, produced the feather-like forms mentioned. Thus the apparent fringe was not in separate portions, as figured of *Osculina*, but in the midst of the transparent sarcode.

The largest of the papilliform inhalant areæ did not exceed the 1-12th of an inch in diameter; and they were all more or less different in shape, varying from a circle to an elongated ellipse. When fully expanded, the diameter of the head or inhalant area was always greater than that of the cylindrical body as it issued from the circular hole of the oyster-shell, and, although funnel-shaped at the commencement, became nearly flat when fully expanded. The body, too, was often inclined or bent to one side, so as to give a drooping position to the head, which, in the elongated elliptical forms, closed by approximation of the sides, and in the round ones by contraction towards the centre.

Although, when somewhat contracted and funnel-shaped, the inhalant area presented the appearance of an osculum, on no occasion were the two seen in the same papilla, as in Schmidt's illustration, nor was there seen any transformation of the inhalant into the excretory papilla, nor *vice versâ*, as might be anticipated from a knowledge of the internal structure connected with these systems in sponges generally. The oscula and inhalant areæ respectively and invariably continued the same.

When first examined, the papillæ had all withdrawn themselves within the margin of the holes in the oyster-shell, but, after rest, began gradually to issue, first in a conical form, when they appeared to be covered with minute black holes, which were the then bare ends of the pin-like spicules bristling in a radiating direction all over the surface of the cone. As, however, the sarcode ascended the spicules (and, so to speak, hung itself out upon them, probably for the purpose of aëration) the whole top fell asunder into the fimbriated form mentioned; while the reverse quickly took place if, under this state, the papillæ were touched with the point of a needle, proving the sensibility of sponges to a mechanical stimulus.

No two papillæ, as before stated, presented exactly the same form; but the general plan in all was that described.

When exposed to the direct rays of the sun, the inhalant areæ all contracted, while the six vents, on the contrary, appeared to be, if anything, more expanded by the same stimulus, —showing, also, that sponges are sensible to light. The inhalant areæ also contracted on motion, while the vents remained unaltered; so that, to observe the former in an expanded state, it was necessary to subject them to as little motion as possible while bringing them under microscopical examination. In short, the vents were seen to continue their office while that of the inhalant areæ appeared to be suspended.

I could see, with the microscope, particles issue from the vents, but could never do so, one way or the other, from the apertures of the inhalant areæ; nor could I see any signs of an inhalant current in the latter by the addition of finely levigated solutions of both carmine and Indian ink, applied separately, such as, under similar circumstances, may always be seen in *Spongilla*.

Then it should be remembered that the incarcerated *Cliona* is probably nourished by the remains of animal matter in the substance of the oyster-shell in which it burrows, while *Spongilla* and the free sponges must obtain it from the surrounding element: hence the inhalant area in the former may be much less active than in the latter; and hence particles of refuse matter may be seen to issue from the vents in *Cliona* while the inhalant areæ are closed.

The largest holes of the vent-papillæ (which only contained one each) were 30-800ths of an inch in diameter, and the largest apertures in the inhalant areæ about the 600th of an inch in diameter; in short, the former were not much less than thirty times as large as the latter.

Spicules.—The smooth, nearly straight, pin-like spicules of *Cliona northumbrica*, which are by far the largest, viz. 73-6000ths or 1-82nd of an inch long in the interior, chiefly occupy the papilla, where, although a little less in size, they exist exclusively of all others and are so numerous as to form the greater part of its bulk; the largest spinous curved fusiform spicules, pointed at each end, which chiefly occupy the sarcode of the interior, are about 25-6000ths inch long; and the minute sinuous ones which accompany them 3-6000ths of an inch. Thus we have the spicule-formula of *C. northumbrica* given by Mr. Hancock (*l. c.*), saving the unimportant trifling discrepancy in measurement.

Lastly, similar sponge-substance to that of the interior, which was present in retiform patches on the exterior of the shell, was found to be charged exclusively with spicules exactly like the large ones of *Grayella*, viz. smooth, straight, more or less cylindrical, round at one end and pointed at the other, 38-6000ths inch long,—a trifle, certainly, less in size, but this does not lessen the significance of the fact.

To the retiform patches of the exterior, charged with the spicules just mentioned, may be added others of a similar kind without spicules, but composed of spherical vesicles and innumerable small monociliated sponge-cells, not unlike the "ampullaceous sac" and its ciliated sponge-cells described in my account of the "Ultimate Structure of *Spongilla*" (Annals, ser. 2. vol. xx. p. 22, pl. 1 : 1857).

To what, then, do these observations lead respecting the point in question? Viz. to the conclusion that *Grayella cyathophora*, *Osculina polystomella*, and *Cliona northumbrica*, if not the Clioniadæ generally, all belong to the same family.

In *Cliona northumbrica* we have the fimbriated inhalant area and the single-holed papillary vent almost exactly like those figured of *Osculina polystomella* (*l. c.*), if we are to regard the latter as inhalant and excurrent openings respectively; and as this inference is based upon observation of an allied species in the *living* state, it seems to me more likely to be correct than Schmidt's interpretation, from resemblances, of the offices of these parts on a dead one, however well preserved in spirit; that is, that Schmidt has, by his own mistake or that of others, assigned the wrong function to the fimbriated papillæ. Surely that little group of pores placed subordinately by the side of an osculum in the same papilla cannot alone be illustrative of the great inhalant system of the beautiful *Osculina*!

Again, the pin-like spicules of *Osculina* can hardly be said to differ from those of the Clioniadæ; while in the fimbriated papillæ these are arranged in a radiated direction with their points projecting beyond the sarcode, just as the spicules are in the papilla of both *Cliona northumbrica* and *Grayella cyathophora*. Indeed there are many pin-like spicules of the former exactly like those of *Osculina*; and the clavate one, also given by Schmidt in fig. 13, is merely a variety of the nearly straight pin-like spicule when found among the latter.

Then, as regards *Grayella*, it is remarkable that the patches of *Cliona northumbrica* on the outside of the oyster-shell and those of the interior should almost exclusively be charged respectively with the same kind of smooth straight, and curved spinous spicules which characterize *Grayella* (Annals, *l. c.*), while the pin-like or larger ones, exclusively of *all* others, occupy the papillæ of *Cliona* and project beyond the sarcode, as the spicules in both *Grayella* and *Osculina*.

Thus the presence of the same kind of papilliform inhalant and excurrent organs, and the same kind of spicules, arranged in the same manner in these three sponges, seems to me indubitably to claim for them all the same family.

It might with justice be stated that the specimen of *Grayella* which I described was also preserved in spirit, and that I also decided "upon resemblances" the offices of the oscular and inhalant papillæ respectively; and, further, it is possible that, in the living state, these papillæ might have presented different forms; perhaps the latter might have presented a fimbriated margin. But, be this as it may, he must be obtuse indeed who could not see in my illustration of *Grayella cyathophora* (which is as true to nature as I could make it) what I saw in the actual specimen, viz. which is which; and it is this which I fancy that I can see in Lacaze-Duthiers's illustrations of *Osculina polystomella*, chiefly through my observations on the living *Cliona*, although I acknowledge that the differences of the two systems in *O. polystomella* are not so unmistakably marked as they are in *Grayella cyathophora*.

Grayella cyathophora and *Osculina polystomella* appear to me to be free forms of the Clioniadæ, such as the so-called genus *Raphyrus*, which is but a free form of *Cliona celata*.

The piece of oyster-shell on which I have made my observations is too free from foreign organisms, both animal and vegetable, for me to suspect that I have been confounding more than one kind of sponge with another, as has been imputed to Mr. Hancock by Dr. Bowerbank (Ray Soc. Pub. 1866, 'Monograph of Brit. Sponges,' vol. ii. p. 216). Undoubtedly it is *Cliona northumbrica*, so truthfully described and illustrated by Mr. Hancock in the 'Annals' (*l. c.*), and under "*Pione*" in Dr. J. E. Gray's proposed arrangement of the Spongiadæ (Proc. Zool. Soc. Lond. May 9, 1867, p. 525). Undoubtedly, too, if the almost liquid Myxogastres can work their way through hard wood to the surface, if the like delicate endophytes *Chytridium*, *Pythium*, &c. can pierce the horn-like coverings of Algæ, and the soft cell of *Zygnema* can dissolve its prison-walls for exit and conjugation, the amœboid sponge can burrow among the layers of an oyster-shell for its subsistence—views so ably put forth by Mr. Hancock (*l. c.*) that I am only astonished how Dr. Bowerbank (*op. cit.* p. 221) could treat such "patient merit" so unworthily.

Almost all that I have stated was written in other and better words by one of my earliest and kindest friends and teachers, Dr. Grant, in 1827 (Edin. New Phil. Journ. vols. i. & ii.), who, at that comparatively early period in the investigation of the nature of the Spongiadæ, assigned the papilliferous *Cliona* to the Zoophytes, from the form of its papillæ, probably, rather than from their function.

Others have since verified his observations, although not altogether according with his conclusions; and my introducing the former again here from personal examination, must plead for excuse only in the special object of comparison for which this examination has been instituted.

I have stated that the pin-like spicules are chiefly confined to the papillæ, where, under certain conditions, they project beyond the sarcode, and under others are more or less covered by it. They come under the designation of Dr. Bowerbank's "defensive spicules," but seem no more to merit that appellation than thorns on rose-bushes. If I might presume to assign any special function to them, without infringing upon the illimitable uses for which every object in nature is provided, it would be that their chief service is to support the delicate sarcode when spread out like branchial appendages, for the purpose of aëration. Of the uses of the other spicules with which the sarcode of *Cliona northumbrica* is charged, both externally and internally, I shrink from even hazarding an opinion.

Lastly, I have above used the expression "so-called genus *Raphyrus*," of whose single species, viz. *Raphyrus Griffithsii*, this beach has afforded me several large and living specimens (one of which I have at this moment in sea-water under examination); and I feel bound to state that whenever I have compared it with a fine specimen of *Cliona celata* found at Exmouth by my friend Mr. Parfitt, who kindly presented it to me, the result has been a corroboration of Dr. Johnston's view, who regarded it as a free form of *Cliona celata*, and a complete subversion of the slender grounds on which Dr. Bowerbank has made it a separate genus (*op. cit.* vol. ii. pp. 215, 216). The specimen of *Cliona celata* which I have mentioned presents the same kind of raised areola, more or less plugged with sponge-substance, over the hole of the oyster-shell from which it protrudes, the same kind of cellular structure interiorly, and the same form and size of pin-like spicule, with its slight capitate variations, as the so-called *Raphyrus Griffithsii*, which to me is but a coarse form of a sponge which, not having the cavities of a shell to support it, has to provide itself with a stronger architecture.

I am not the first person, too, who has noticed *Cliona northumbrica* in this neighbourhood; for it is mentioned by my intelligent friend Mr. Parfitt in his paper on the "Marine and Freshwater Sponges of Devonshire," printed in the Trans. Dev. Assoc. for Advancement of Sc. & Lit. 1868, where, under Dr. Gray's name of "*Pione*," he states that *Cliona northumbrica* is not uncommonly dredged off the south coast of Devon, "in *Buccinum undatum* and in the old valves of *Cardium edule*," testifying at the same time to the "excellent" description of this species, in the 'Annals,' by Mr. Albany Hancock.

In my specimen, which is not much the worse for ten days' confinement, there are no raised areolæ of sponge-substance (spicules and sarcode) bordering the holes in the oyster-shell, as in the specimens of *Cliona celata* and *Raphyrus Griffithsii* to which I have alluded; and I think it not improbable that, although the papillæ would be much contracted by death, still some of them would remain much beyond the holes in the oyster-shell, which, if dissolved off, would give them a similarly elevated position above the other sponge-substance to that presented by the papillæ in *Grayella* and *Osculina*.

Postscript.

Since the above was written, three or four of the inhalant papillæ, now in a semicontracted condition, on the concave side of the oyster-shell, have presented a single funnel-shaped hole in the centre respectively, which, being so much larger than the original apertures, led me to think that they must be vents; but on placing them under the microscope, particles were observed to be whirled into them, apparently in a spiral manner, showing at once that they were not vents, and affording positive evidence, which had not been before obtained, of the inhalant function of these papillæ.

The vents are still active, and the inhalant papillæ as sensitive to light as when first the *Cliona* was placed in confinement (now thirteen days ago), which would hardly have been the case had the *Cliona* not been drawing its nourishment from the organic matter in the oyster-shell. On the other hand, a living piece of *Raphyrus Griffithsii* (which I regard as a free form of *Cliona celata*), and which was placed in sea-water renewed as often as that of the *Cliona*, ceased, after three days, to show any active signs of life whatever.

The papillæ which presented respectively the single funnel-shaped hole in the centre were, with the exception of the rim, very like Schmidt's figs. 10 & 11 of *Osculina polystomella* (*l. c.*).

Finally, it should be noticed that the papillæ in *Cliona northumbrica* ceased to present their fimbriated forms about the sixth day after confinement, and, showing signs of decline generally about the 18th, it was transferred to spirit and water for preservation.

Dec. 31, 1869.—On this day I picked up on the beach, after a heavy gale from the south, among other living specimens of sponges, two compact portions, rounded off by friction among the shingle, each about 1½ inch long, not quite so broad, and rather compressed, of a light yellow colour tinged with red, and presenting a single large hole at one part. They were portions of *Halichondria suberea*, Johnston (Brit. Spong. p. 139, pl. 12. figs. 4-6); and on making a longitudinal section of them respectively, each displayed the interior cavity of a univalve shell, about an inch long, with the spire and columella complete; only the whole was composed of sponge-substance, just as much as if it had been analogously lapidified by fossilization. Indeed, to use a mineralogical term, the sponge internally was a pseudomorph of the shell it had replaced. How the cavity of the shell had been maintained during the transition can only be accounted for by the presence of a hermit-crab (*Pagurus*), which, although still in one of the specimens, had quitted the other; so that the *Pagurus* must have been in the cavity of the shell all the time that it was being replaced, particle after particle, by the sponge—a process, however, which might have gone on very rapidly, as inferred by Montagu (*ap.* Johnston, p. 140, *l. c.*).

This was not all; for each sponge had enclosed at the summit of the columella a little *Murex* (*corallinus*?), about four lines long, fresh in appearance, but empty, on which were deposited, both inside and out, but chiefly between the costæ, lines of spherical gemmules, of a yellow colour, and varying from 4- to 8-830ths of an inch in diameter, which gemmules were themselves already sunk to almost half their diameter into the substance of the *Murex*.

The gemmule was composed (when nearly dry, in which state the specimens were examined) of a minutely dimpled, amber-looking, soft, coriaceous envelope, lined by one more delicate, colourless, and transparent, containing a number of spherical cells about 1-1660th of an inch in diameter—in short, just like the gemmule or so-called seed-like body of *Spongilla*, whose grouping (here exclusively round the little *Murex*) they otherwise generally resembled.

This at once decides the question of the possibility of certain sponges feeding on the organic matter of shell-substance, just as certain Fungi feed on woody tissue. And in this instance, we must regard this sponge (*Halichondria suberea*), from its habit, true pin-like spicule (that is, with a turban-like head), compact structure, minute cancelli, and small, although defined, canalicular system, as one of Dr. J. E. Gray's family of Clioniadæ.

The yellow colour and dimpled appearance, respectively, presented by the coriaceous envelope of the gemmule is owing to its being composed of minute spherical cellules, about 1-3700th of an inch in diameter, situated about the same distance from each other, but united together, in a stellate form, by intervening straight tubules, five or six in number, radiating from each cellule, similar to what is seen in the microscopic cell-structure of fossil Foraminifera, ex. gr. *Orbitoides*; and it is in the intervals between the cellules and radii that the dimples occur.

XI.—*Reply to* Mr. Frederick Smith *on the Relations between Wasps and* Rhipiphori. By Andrew Murray, F.L.S.

I was much pleased to read my friend Mr. Frederick Smith's commentary on my paper about Wasps and *Rhipiphori* in the last Number of the 'Annals,' although I see that I have not succeeded in converting him to my views. There is nothing like the collision of opposing minds for eliciting truth; and it is always pleasant to find another taking interest in a subject which has excited our own, especially when it is so fairly and honestly handled as every subject is on which Mr. Smith expresses his opinion.

With the help of that fairness, I do not yet despair of bringing him round; and for that purpose, as well as for the sake of those who may have been convinced by his arguments or led away by the authority of his opinion on a subject on which he is *facile princeps*, I shall ask him and them again to weigh the difficulties which his view of the question presents. In my last paper I was more concerned in stating my own observations than in controverting the opinions of others; but I shall now pass in review the whole facts that we know on the subject, either from Mr. Smith, Mr. Stone, myself, or others, and endeavour to see with which explanation they best agree.

Mr. Smith agrees with me that the *Rhipiphorus* lays its eggs in the cells of the wasps, and that in the instances in which I saw two eggs in one cell, one of them must have been a *Rhipiphorus*; that gives us the form of its egg and its position and mode of attachment in the cell (which are all identical with those of the wasp's). When the wasp's egg is examined in its early stage, it is seen to be simply an oval egg, with a smooth semitranslucent shell, through which, at a later period, the form of the larva can be distinguished, when viewed as a transparent object. It is fixed, by the narrow end, in an angle of the cell about a third of the way from its base. By-and-by it looks as if it had a head, and by-and-by like a larva holding on by the tail. How it comes out of the shell, or whether it ever comes out of the shell, I do not know; most likely Mr. Smith can say. It may be that the egg-shell is absorbed and becomes practically the first skin of the larva. Looked at later, or, I should rather say, in a further advanced specimen (for that is the way in which the changes practically are observed), we find the larva nearer the base of the cell: it is travelling to the bottom. It cannot fall out of the egg-shell to reach it at one stroke; for the cell is mouth down and the bottom is at the top: it cannot fall up; it therefore has to work upwards. How it does so, is, I think, not known. It is said by some to be by throwing itself into a loop and catching hold of the wall of the cell with its teeth, then releasing the tail and throwing another loop, fastening its tail again as a sucker and releasing its head, and so on, by a succession of slow summersaults; but this to me seems impossible. At the stage in question it is a dumpy fat oval thing which, to all appearance, could no more bend itself into a loop than a hogshead could. But be that as it may, somehow or other thé young larva manages to wriggle itself (perhaps by slow action of its sucker tail) up to the bottom of the cell. Now the first question I should like to ask Mr. Smith is, whether this helpless larva is fed by the parent wasps before it reaches its goal, the bottom of the cell, or not. I see no reason why it should not, but almost a necessity that it should. The journey to it, especially if made by the process of shifting its sucker tail without letting go its hold, must not only be a slow one, but one involving considerable exertion. We all know (that is, all entomologists know) how soon a larva freshly excluded from the egg shrivels up if its food is not at its mouth the moment it comes out, and we are never tired of admiring the wonderful precautions which the parent insect takes to ensure that its offspring shall find itself in the midst of plenty from the very first. I therefore believe that it *is* fed, and fed with soft food fitted for its tender jaws.

But how about the young *Rhipiphorus*-larva? Is it fed too? And here it is scarcely a digression (certainly not an irrelevant one) to ask what the larva is like. So far as I know, it has never been properly described or figured. Candèze and Chapuis, in their works on the larvæ of Coleoptera, give no description; they refer to a notice of it by Ramdohr in Germar's Mag. für Entom. i. (1813) p. 137, but which is without description. Neither does Westwood give or refer to any description in his great work; and I can find none anywhere else. Mr. Stone is the first who gives some details about it: his description is as follows:—

"The larva is a singular-looking one. The head is bent forward under the body; between the segments it is more deeply furrowed than any larva with which I am acquainted. A longitudinal furrow extends down the back from the head to the anal extremity, cutting each segment across. The skin, during life, throughout the whole of the course of this furrow, is perfectly transparent, so that the workings of the internal organs may be plainly seen. The body of the larva, while alive, has the appearance of a thin transparent skin filled with minute particles of curd. These appearances vanish after death, when the body becomes dense and has an appearance of solidity about it which it had not before." (Stone in 'Zoologist,' 1865, xxiii. p. 9462.)

But this description is obviously imperfect. He does not tell us whether it has feet or not—a not unimportant point when the question is whether the larva passes a nearly motionless life in one cell, or a roving one, preying upon grubs in other cells. But the context implies that it is like the grub of the wasp, and consequently apodal; and Mr. Smith informs me that it is so. I remember perfectly, in my examination of the wasps' nest out of which this question has arisen, seeing plenty of grubs with the back so transparent as to show the inside like curds shining through. If these were the larvæ of the *Rhipiphorus*, then they are as like to the wasp-grub as one pea to another—so like, in fact, that they did not attract my attention as being distinct. Their powers of motion, then, are similar to those of the wasp; and I state it as a fact beyond contradiction that the wasp-grub *cannot* walk. When taken from its cell, it lies like a sack of meal: it may wriggle a little; but as to rising up and walking, it can no more do it than the sack can. Once fixed and hanging by the tail, all they can do seems to be to shift their position a little. But, passing that, the question I ask is, how the *Rhipiphorus*-larvæ are sustained at first until they reach their supposed prey, if not by the wasp-nurses. The journey of the young larva, according to Mr. Smith's view, is in an opposite direction to that of the wasp's, viz. to the mouth of the cell, to go roving about in search of a wasp-larva on which to pounce and prey; its journey is thus longer. It must be a longer time without food, and undergo greater exertion requiring food, travelling about like a Blondin on the edges of the cells—only like a Blondin upside down;

and when it gets to its food (the wasp-grub), it has a tough skin for its tender young jaws to break through before it can begin, and must encounter the risk of being first gobbled up by the big wasp-grub, whose jaws are gaping for food at the very door. It seems to me that it would be a safe speculation to lay long odds on the wasp-grub having the best of it. If Mr. Smith says it is not fed at all until it takes a wasp-grub at unawares, then I invite him to consider the difficulties attending the promenade which he supposes it to make before breaking its fast. If he admits that it must be fed by the wasps to begin with, then I ask him to say, on abstract grounds (putting Mr. Stone's observations out of view for the present), why he should object to its being fed by the wasps more at one time of its life than another.

But there are more anomalies in Mr. Smith's way than that. Suppose that it does not require to be fed, or that, if it requires to be fed, it is fed by the wasps until it reaches its victim, and that then it escapes its jaws and fastens upon it, I want Mr. Smith to say whether it feeds only upon one victim, or if, after eating it up, it comes out again, and goes roaming about from cell to cell, destroying a succession of grubs. It must do either the one or the other. Let us test both. First, that it only destroys one grub. As the *Rhipiphorus*-pupæ and perfect insects ready to come out are always found in cells closed-in by a lid which Mr. Smith maintains to be spun by the wasp-larvæ*, the *Rhipiphorus*-grub must make its lodgment in the victim's cell just before it is beginning to spin, and must make so little progress in its attack upon it at first as to leave it at least power to spin the lid. When it is spun, the two will then be shut up together, and the little tiny grub has full scope to tear away at the vitals of the wasp, probably now become a pupa. But does Mr. Smith think that a meal of one animal can suffice to nourish another into as great dimensions as the animal eaten. True, a caterpillar infested with ichneumons often nourishes within its bosom a tribe of parasites whose aggregate bulk is not much inferior to its own; but they have not had merely a mass to eat equal to its bulk; they have grown with its growth, and fresh food has been assimilated for them day by day—so that they have eaten the

* I have to acknowledge the justness of Mr. Smith's correction of a *lapsus pennæ* in my last paper, where I spoke of the pupæ spinning these lids, instead of the larvæ. The contrast in my line of thought was not between pupæ and larvæ, but between the lid being spun by the creature inside the cell or lid, or by the parents outside. Of course when the larva changes into a nearly motionless inactive pupa, there could be no question of spinning. The error corrected itself.

bulk of many caterpillars. With the *Rhipiphorus* there is nothing of this. The assumption is that it attacks from without. The wasp-larva or pupa has ceased to eat, or if not already ceased, the attacks of its enemy will soon make it cease; and all that the little larva of the *Rhipiphorus* has to feed upon and grow as large as the wasp upon is the one mass of meat no larger than what it is to grow to. This is the view which Mr. Stone and, following him, Mr. Smith adopt. Mr. Stone's observation is that the *Rhipiphorus*-larva which he found attacking a wasp-larva in a sealed-up cell (which, by the way, must only have been recently closed, or it would have had within it not a wasp-larva, but a wasp-pupa) "was of *minute size* when discovered, and appeared to have only recently fastened on its victim; but so voracious was its appetite, and so rapid its growth, that in the course of the following forty-eight hours it attained its full size." Now if by "*minute size*" we suppose a line or a line and a half in length, it must have grown three or four times its own size in forty-eight hours, which is so opposed to everything we know of the laws of development and assimilation that I cannot accept it. If we look at the little black deposit of digested débris at the bottom of the wasps' cells, we find fragments indicating the consumption of hundreds of insects not much smaller than themselves: there is the same at the bottom of the cells of the *Rhipiphori*; but I refrain from using that as an argument, because Mr. Smith might plead that I cannot prove that the black deposit in their cells was not the product of former wasp-tenants who had been reared in the same cell.

Let it not be supposed for a moment that I at all doubt that Mr. Stone thought he saw this; but I think his observation has been inaccurate; and I try to account for it in this way:—It is plain he could not have kept his eye constantly fixed on this specimen for forty-eight hours; we may assume that he did not sit up two nights running to watch it. He saw it attacking the wasp-larva and eating at it voraciously (the meaning of that and of some other of his observations I shall discuss presently), and he left it so occupied. He returned to it, how soon or how often he does not tell us; but when he did return, and found it so increased in bulk, I cannot but believe that he mistook the cell, and, instead of looking into the one he left, looked into another where was a mature *Rhipiphorus*-larva, which had had nothing to do with the meal on the wasp. Any one who has ever tried the experiment of endeavouring to find a particular cell in a comb after removing his eyes from it, for however brief a space, will know that nothing could be easier than to make such a mistake. I can speak to it from experience. In placing the nest from which I took my *Rhipiphori* in the South-Kensington Museum, I thought it might be desirable to mark the cells out of which I had taken *Rhipiphori*; and I accordingly set about doing so by painting blue the lid of each cell out of which I took one. At first I attempted to do it by first taking out the insect and then painting the lid; but I found the short space of time between laying down the forceps and taking up the painting-brush sufficient to efface or render uncertain the identity of the cell from which it had been taken. I therefore had to take the precaution of painting the half-opened lid before I drew out the *Rhipiphorus*.

But, further, if the rate and mode of growth of the *Rhipiphori* is that stated, they should always be found engaged in the way Mr. Stone describes. They should always be found in sealed cells, if one wasp-grub is sufficient to nourish them; whereas this is the only instance that has ever been observed of it. (Mr. Smith says no; but I shall presently show that it is.) Mr. Stone himself records having found a number of larvæ of *Rhipiphorus* which we may fairly infer were not so occupied, for he would have recorded it had they been so: two he mentions having found solitary in worker-cells; and although he does not specify where or how he found the others engaged, still, if not in a cell with a wasp-grub, there is only one other place for them to be found in, viz. solitary in cells by themselves. Now I should like Mr. Smith to say what the mass of the larvæ are doing in cells by themselves. If it had been pupæ, we might have inferred that they had completed their task, eaten up their man, and retired from active life: but larvæ are different; they have still more or less of their task to do. Again, if Mr. Stone's observation is correct, we should never see any half-grown larvæ. There should be no medium between a "minute" one and a full-grown one, except during the forty-eight hours at which it is at its meal; but Mr. Smith speaks of specimens of under-grown larvæ; and if I am to suppose that the grubs I saw with a curd-like interior shining through the back were *Rhipiphorus*-grubs, then I can say for myself that I saw them of all sizes. In relation to this I may remark that Mr. Smith founds on the size of the perfect insect an argument which I am sure, on reconsideration, he will abandon. He argues that insects which in their larval state are dependent for their sustenance on chance or irregular supplies of food are apt to vary much in size, which is quite true; but he goes on to instance the *Rhipiphorus* as one of the examples of parasites that differ greatly in size. Now this, although true to the letter, is not true in

A strongly marked species, its habit suggesting the North-American genus *Nosoderma*.

Amarygmus tyrrhenus.*

A. suboblongo-ovalis, violaceo-purpureus, vel violaceo-chalybeatus, nitidus; elytris parallelis, striato-punctatis, punctis subapproximatis, interstitiis modice convexis, vix punctatis; tarsis sat gracilibus.

Hab. Western Australia.

Moderately oblong-oval, violet-purple, or steel-blue with a violet tinge, glossy, and more or less varying according to the light; head not closely punctured, a little convex between the eyes; antennæ black, rather short; prothorax rather transverse, minutely and somewhat remotely punctured; scutellum curvilinearly triangular; elytra somewhat narrow comparatively, the sides parallel, striato-punctate, the punctures rather close, the intervals of the striæ moderately convex, nearly impunctate, or with a very minute puncture here and there; body beneath glossy, black; legs dark steel-blue. Length 4–5 lines.

A striated species, with rather narrow elytra, especially in the male—a character by which it appears to be well differentiated. Mr. Masters sends me a specimen of *A. Howittii* (*ante*, vol. iii. p. 348) from Port Lincoln, much more coppery than the two I received from Dr. Howitt; also two individuals of *A. suturalis* (*ante*, vol. iii. p. 350), one of which is destitute of the rich colour (bright golden green in the other) which adorns the type specimen.

Amarygmus maurulus.

A. ovalis, niger, vix nitidus; elytris cyaneo-nigris, leviter striato-punctatis; pedibus antennisque ferrugineis.

Hab. New South Wales (Illawara).

Oval, or in one sex narrowly oval, black, scarcely shining; head rather narrow, almost impunctate, the clypeus distinctly punctured; antennæ slender, ferruginous; prothorax moderately transverse, impunctate; scutellum triangular; elytra dark blue-black, finely striate, the striæ with elongate, slightly approximate punctures, the intervals of the striæ rather broad, not convex, with a very delicate scattered punctation; body beneath blackish brown; legs ferruginous, the femora glossy, tarsi slender. Length 3–3½ lines.

A small dull-looking insect, approaching *A. tarsalis*, but with a more approximate punctation on the elytra, and differently coloured.

* Dalman, Anal. Entom. p. 60.

Amarygmus variolaris.

A. subanguste ovatus, æreus, subnitidus; elytris punctis distinctissimis irregulariter dispersis.

Hab. Queensland (Wide Bay, under the bark of trees).

Rather narrowly ovate, yellowish brassy, not very glossy; head rather broad, finely and somewhat sparingly punctured; antennæ brownish chestnut, the third joint shorter than the two next together; prothorax strongly transverse, finely punctured; scutellum triangular; elytra oblong, moderately convex, the sides very gradually narrowing from the base, more rapidly rounding towards the apex, with opaque, dark-greenish, irregularly dispersed, and somewhat distant punctures; body beneath yellowish brassy, shining; legs glossy brownish chestnut. Length $3\frac{3}{4}$ lines.

One of the most distinct species of the genus, on account of the peculiar sculpture of the elytra. Of the two specimens which I received from Mr. Masters, one (the male?) has the three basal joints of the anterior tarsi short and strongly dilated,—while in the other they are very slender and elongate; the antennæ are also almost linear, with the outer joints oblong: in the former the antennæ are imperfect, but they appear to be stouter.

Eurypera.

(Subfamily *Amarygminæ.*)

Caput ad oculos retractum.
Oculi supra haud approximati.
Tarsi subtus pilosi.

Except that the body is shorter and more convex, the rest of the character is as in *Amarygmus.* The terminal joint of the labial palpi is so large as nearly to cover the labium; but this is only a modification of the *Amarygmus*-character.

Eurypera cuprea.

E. cupreo-metallica, nitida; antennis, pedibus, corpore infra, nigris, glabris.

Hab. Queensland (Port Denison).

Reddish copper, shining; head finely and rather sparingly punctured; upper lip black, connected with the clypeus by a bright orange membrane; prothorax very transverse, gradually broader and rounded at the sides, the apex moderately emarginate, the disk covered with fine distant punctures; scutellum triangular; elytra not broader than the prothorax at the base, strongly rounded at the sides, finely sulcate, the sulci black, with oblong, distant, indistinct punctures, the intervals very minutely punctured; body beneath and legs black, glabrous, shining; antennæ black, slightly thicker outwards. Length $4\frac{1}{2}$–5 lines.

XIII.—*On the Organization of Sponges, and their Relationship to the Corals.* By Ernst Häckel.

[Continued from p. 13.]

What raises our deduction as to the common origin and genealogical relationship of the sponges and corals to a perfect certainty is the hitherto entirely overlooked *fundamental agreement of the sponges and corals* (*and, indeed, of all the Cœlenterata*) *in the ontogenetic building-up of their body from two different layers of cells or germ-lamellæ—the entoderm and ectoderm.* In all Sponges (just as in all Acalephs, Corals, Hydromedusæ, and Ctenophora) all the parts of the body are developed by the differentiation of two distinct cellular layers —an inner formative membrane, the *entoderm*, and an outer formative membrane, the *ectoderm. In all Sponges, as in all Acalephs*, the inner germ-lamella (or entoderm) forms the epithelial lining of the nutrient canal-system, as well as the spores or sexual products (ova and zoospermia), which are nothing more than sexually differentiated cells of this canal-epithelium; the outer germ-lamella (or ectoderm), on the other hand, forms the entire external wall of the canal-system and the principal mass of the body in general, which is differentiated in the higher Sponges and Acalephs into epidermis, connective tissue, skeletal parts, muscles, &c. *The cells produced from the entoderm or inner formative membrane perform the vegetative functions of nutrition and reproduction both in the Sponges and in the Acalephs. The cells which originate from the ectoderm or outer formative membrane, on the other hand, perform the animal functions of movement and sensation*, and serve also as a *protective covering* and as *supporting skeletal parts* for the whole body. It will therefore seem to be not inappropriate if in *all Cœlenterata* (i. e. *in all Sponges and Acalephs*) we designate the *entoderm* (or inner formative cell-layer) *as the vegetative germ-lamella*, and the *ectoderm* (or outer formative cell-layer) *as the animal germ-lamella.* The wide view which is presented to us by this conception, and by its comparison with the corresponding relations of the germ-lamellæ in the higher animals, and which is well adapted to elucidate the primitive relationship of all the stems of the animal kingdom, *i. e.* the common derivation of all animal *phyla*, will be explained more fully in my Monograph of the Calcispongiæ.

I will admit that this law, which appears to me to be of high importance, is subject to certain modifications in many individual cases, and that perhaps here and there, in both the Sponges and Acalephs, the two germ-lamellæ or formative membranes (the entoderm and ectoderm) may replace each other by *local substitution*. Not unfrequently the entoderm is lost over large spaces, and is replaced by the ectoderm. In some, perhaps in many cases (both in Sponges and Acalephs), the different signification of the two divergent germ-lamellæ is, in particular parts of the body, not clearly recognizable, or even actually changed. Thus, for instance, *perhaps* in both groups of animals, sexual products may sometimes be developed from the ectoderm and muscles from the entoderm. But then, probably, these deviations and local substitutions of the two lamellæ are to be regarded as *secondary modifications, only produced at a late period by adaptation. The original primary relation inherited by all Sponges and Acalephs from the common trunk-form* (Protascus) *is probably that described above*: the *entoderm*, as the *inner, vegetative germ-lamella*, forms the nutrient cells of the canal-epithelium, and the cells produced from these, by division of labour, serving for the purpose of reproduction (germ-cells or spores, ova and zoospermia); whilst the *ectoderm*, as the *outer, animal germ-lamella*, forms the muscles, nerves, skeletal parts, outer covering, &c.

This law finds its strongest support in the structure of the young forms of the two groups of animals, which have been already referred to. The cup-shaped young state, produced from the ciliated larva, which possesses a simple stomachal cavity (or digestive body-cavity) with a single, simple aperture (or mouth), and which, in the living *Prosycum*, still recalls to us the long-lost picture of the *Protascus*, shows us its simple solid body-wall (or stomach-wall) composed throughout of the two distinctly differentiated formative membranes, the entoderm and the ectoderm, and, indeed, equally in the corresponding young states of the Spongiæ as in those of the corals and the Acalephs generally. Here, again, however, the Calcispongiæ serve as admirable elucidatory objects, because, on the one hand, of all Sponges they approach nearest to the corals, and, on the other, in the graduated evolution of their simple organization, from the very simple *Prosycum* and *Olynthus*, up to the highly developed *Dunstervillia* and *Cyathiscus*, they bring wonderfully before our eyes the continual separation of the two originally divergent formative membranes, the vegetative entoderm and the animal ectoderm, notwithstanding their further differentiation to various higher structures.

In all Calcispongiæ without exception (although in some more distinctly than in others), the fundamental and original difference of the two formative membranes stands out so distinctly, and may be so readily and clearly traced in their further divergence, even up to the most highly developed forms, that it may be at all times visibly demonstrated. Consequently it has not escaped those naturalists who have most carefully investigated the structure of the Calcispongiæ. Here and there they all speak of the different layers of the body-wall; but none of them has indicated their general and genetic significance, and no one has perceived that the entoderm produces exclusively the epithelium of the canal-system, which performs the function of nutrition, and the cells serving for reproduction, and the ectoderm all the other cells. For this reason I may be permitted here to adduce some special circumstances connected with the structure of the body in the Calcispongiæ, the detailed description of which, and their elucidation by figures, I reserve for my monograph.

The *entoderm*, or inner formative membrane of the Calcispongiæ, produced from the inner cell-layer or vegetative germ-lamella of the embryo, originally lines the whole inner surface of the nutrient canal-system or gastrovascular system in the form of a single continuous cell-layer of flagellated epithelium. By the expression *flagellated epithelium* (Geissel-Epithel, epithelium flagellatum) I understand an epithelial cell-layer, *each cell of which bears a single vibratile hair* (flagellum), in contradistinction to *ciliated epithelium* (Wimper-Epithel, epithelium ciliatum), *each cell of which bears two or more vibratile hairs* (Wimpern, cilia). Flagellated and ciliated epithelia are to be distinguished as two different modifications of *vibratile epithelium* (Flimmer-Epithel, epithelium vibratorium). *In all sponges the vibratile epithelium appears to occur exclusively in the form of flagellated epithelium, and never in that of ciliated epithelium.* This applies both to the vibratile cells which line the inner surface of the canal-system and to those which clothe the outer surface of the vibratile swimming larva. In both cases the epithelial cells are always monotrichal, flagellate cells, and never polytrichal, ciliate cells. The flagellate cells of the sponges are perfectly naked and membraneless; their protoplasm passes directly into the long flagellum, which is thicker at the base. In the flagellate cells I have never failed to find a distinct nucleus. It is usually of very considerable size, one-half or two-thirds as large as the cell. Generally the flagellate cells line the walls of the canal-system only in a single layer; rarely several layers are superimposed upon each other. Such stratified flagellate epithelium occurs, for example, in *Tarroma* and *Clathrina.*

Besides the flagellate cells, the entoderm of the sponges gives origin only to one product, the *ova.* Although here, following the example of all authors, I denominate the *germ-cells* or reproductive cells of the sponges *ova*, this is not without great hesitation. Thus, although I have most carefully examined with the microscope hundreds of Calcispongiæ, I have never succeeded, either in these or in the other sponges investigated by me, in detecting any trace of fecundating male elements or zoospermia. I have thus become very suspicious of the generally accepted *sexual differentiation of the sponges* in general. The only accounts of zoospermia in sponges which seem to merit confidence (although they still require confirmation) are those of Lieberkühn with regard to *Spongilla.* What Carter describes as the zoospermia of *Spongilla* are, as Lieberkühn perceived, Infusoria; and what Huxley figures as the zoospermia of *Thetya* are very probably vibratile cells. No less doubtful are the filaments which Kölliker describes as the zoospermia of *Esperia.* Scepticism as to the occurrence of zoospermia in sponges appears the more justifiable because, on the one hand, the detached flagella of the flagellate cells, which move briskly, may very easily be mistaken for motile seminal filaments, and, on the other, many of the most experienced observers, such as O. Schmidt and Bowerbank, who have examined microscopically thousands of sponges, have, like myself, sought in vain for male organs of any kind whatever. I regard it, therefore, as most prudent and advisable, for the present, to doubt the sexuality of the sponges. But then the cells subserving reproduction, the germ-cells (*gonocyta*), must be designated not as *sexual eggs* (ova), but as *asexual germ-cells* (sporæ).

I have found the spores or so-called ova, in all sponges investigated by me, to be perfectly naked and destitute of membrane, like the flagellate cells from which they proceed. *Throughout I have never found in the sponges examined by me any trace of a membrane or true cell-membrane on the cells. All sponge-cells are naked cells without envelopes* (gymnocyta). The spores of the Calcispongiæ have hitherto been seen only by Lieberkühn in *Sycum ciliatum*, and by Kölliker in *Tarrus* and *Dunstervillia.* I have never missed them in any of the *mature* Calcispongiæ investigated by me. They are very easily recognized, as they are distinguished at once from the flagellate cells by their very considerable size and the absence of the flagellum, whilst no other independently persistent cells (except these two cell-forms of the entoderm) occur in the body of the Calcispongiæ.

The *mode of production of the spores* or so-called ova of the sponges has hitherto been unknown. In my monograph I shall demonstrate that they proceed directly from the flagellate cells, and consequently are *products of differentiation of the entoderm, or metamorphosed flagellate cells.* The simple and extremely significant fact that the reproductive cells are produced, by division of labour, from the nutrient vibratile cells of the entoderm or vegetative germ-lamella applies also to the sponges equally with the Acalephs. According to Kölliker, the spores of *Dunstervillia* and *Tarrus* lie outside the vibratile epithelium in the ectoderm. But they only get there when, from the increase of their bulk, they can no longer find room among the surrounding flagellate cells of the entoderm. They then project sometimes into the ectoderm and sometimes into the lumen of the canals. I have never found special spore-capsules in the Calcispongiæ, but the spores may develope themselves from the flagellate cells on the most different spots in the entoderm. What Lieberkühn describes in *Sycum* as a special "receptacle for the ova, without demonstrable structure," I have never seen, and I suppose that these asserted spore-capsules are transversely cut canals.

As Kölliker has already pointed out, the spores of the sponges have a remarkable resemblance to large ganglionic cells. This is due to the fact that the protoplasm of the cells emits from the periphery polymorphic branched processes. *The spores of the Calcispongiæ resemble large* Amœbæ, *and perform amœboid movements*, by extending and retracting such branched processes. In a state of repose, they are spherical or polyhedral. Each spore possesses a very large, usually spherical, and limpid nucleus. This encloses a large, round, dark, nucleolus, and this, again, a distinct nucleolinus.

The Spongiæ are in part sporiparous and in part viviparous. In the sporiparous sponges (e. g. *Leucosolenia*, *Clistolynthus*) the mature spores drop out of the entoderm into the stomachal cavity or into the parietal canals issuing from the latter, and are then cast forth through the mouth in the forms which are provided with a mouth, whilst in astomatous sponges they creep out through the cutaneous pores. In the latter case their amœboid movements will be of essential assistance to them.

In the viviparous sponges (e. g. *Olynthus*, *Clathrina*) a spherical body (embryo), composed entirely of similar naked nucleated cells, is produced from the simple spore-cell by continued division ("segmentation") within the body of the sponge (either in the stomach or in the parietal canals issuing from it. Each of the cells situated on its surface emits a filamentous process, and thus becomes a flagellate cell. Then there is produced in the interior of this vibratile embryo a central cavity (stomach), which, sooner or later breaking through to the outside, acquires an orifice (mouth). As has already been remarked, the wall of this simple stomachal cavity (body-cavity) then becomes differentiated into two different cellular layers. After the vibratile larva has issued from the parent body, and come to rest after swimming about for a time, the cells of the outer surface retract their flagella, become fused together, and thus form the ectoderm. On the contrary, those cells which surround the stomachal cavity emit each a filiform process, and thus become flagellate cells and form the entoderm. It is only much later, when the sponge has attained its true maturity, that the spores are produced from individual cells of the entoderm.

The body-wall, or stomachal wall of the freely swimming, ovate, vibratile larvæ, the entire canal-system of which consists of a simple stomachal cavity with a mouth-orifice, is composed, in the smaller Calcispongiæ (e. g. *Olynthus*, *Nardoa*), only of two layers of cells, the ectoderm and the entoderm each forming only a single layer of cells. In the larger Calcispongiæ, on the contrary (e. g. *Dunstervillia*, *Clathrina*), each of the two sets of cells may divide into several layers.

The *ectoderm* or outer formative membrane *of the Calcispongiæ*, produced from the outer cell-layer or animal germ-lamella of the embryo, always forms more than half the volume of the body, as it is always thicker (often several times) than the entoderm. *The ectoderm consists of intimately amalgamated naked cells*, the nuclei of which are always at first, and usually even at later periods, distinctly visible in the united protoplasm, which is frequently differentiated in various ways. The nuclei are generally of an elongate-rounded form, and frequently surrounded by an aggregation of fine granules, which not rarely radiate from the nucleus and extend in various directions into the protoplasm. Although in the ectoderm of the mature Calcispongiæ, the apparently almost homogeneous, nearly structureless, fundamental substance, charged with nuclei and skeletal spicules, no longer allows any trace of the amalgamated cells of which it is composed to be recognized, it has nevertheless been *actually produced from originally separated cells by their subsequent fusion*, as is clearly proved by the ontogeny of the embryos and larvæ. The ectoderm therefore does not merit the name of true *sarcode*, if under this notion we understand free and *primitive protoplasm not yet differentiated into cells.* The denomination *syncytium* or *sarcodine* might perhaps seem more suitable for it.

The ectoderm of the Calcispongiæ, which becomes converted by the *fusion of the originally separate cells* of the outer or animal germ-lamella into the in some respects *retromorphosed* tissue of the *sarcodine* or *syncytium*, represents, physiologically considered, a tissue which performs the whole of the animal functions of the sponge-body—*movement*, *sensation*, *support*, and *covering*. The amalgamated protoplasm of the sarcodine is *contractile* and *sensitive*, *forms the skeleton*, and *covers* the surface of the body. It therefore, as it were, unites *in one person* the four functions which, in the higher animals, are separated and distributed over the four tissue-systems of the muscles, nerves, skeletogenetic connective substances, and epidermoidal covering.

In a morphological point of view, of all the functions of the ectoderm its *skeletogenetic* activity indisputably produces the most important results. The *skeleton* of the Calcispongiæ, as indeed of all other sponges, is *purely the product of the ectoderm*—and, indeed, never a simple exudation, an "external plasma-product," as I have expressed this idea in my 'General Morphology,' but always an *internal plasma-product*. The *quæstio vexata*, so often ventilated, whether the skeletal parts of the sponges are or are not produced in the interior of cells, is solved by the developmental history. When the skeletogenetic protoplasm still persists in the form of a distinct cell provided with a nucleus, the spicules are produced in the interior of this cell. But when the skeletogenetic cells have already become fused together to form *sarcodine*, the skeletal parts are produced in the interior of this syncytium. *The skeletal parts of the sponges are never produced at the free surface of the ectoderm, but always in its interior.*

In the calcareous skeleton of the Calcispongiæ, by which these sponges are distinguished from all others, we may with comparative ease convince ourselves of this fact. The spicules of the calcareous skeleton are in them either entirely concealed in the modified protoplasm of the ectoderm, or, when they project freely from its surface, they are still coated, as if with a sheath, by a thin layer of the protoplasm. This character, first indicated by Kölliker in *Tarrus spongiosus* (his *Nardoa spongiosa*), has occurred to me more or less distinctly throughout the Calcispongiæ. Moreover *in certain cases* the calcareous spicules contain a central canal filled with protoplasm, such as occurs almost universally in the siliceous spicules of the siliceous sponges. Lastly, in many (perhaps in all?) Calcispongiæ the carbonate of lime of the skeleton appears not to be deposited quite pure, but to be intimately combined with a more or less considerable quantity of organic substance (modified protoplasm). In many Calcispongiæ the carbon-compound takes so considerable a share in the formation of the skeletal parts, that the latter, after the extraction of the carbonate of lime by muriatic acid, remain quite unchanged in form and size, whilst only a slight residue of molecular calcareous dust is left after calcination.

The *forms of the skeletal parts* or spicules in the Calcispongiæ are, as is well known, by no means so multifarious as in the Silicispongiæ. Only the four following fundamental forms occur, with various modifications:—1. Simple spicules (linear, cylindrical, or fusiform), frequent. 2. Two-limbed spicules (forked or hooked), very rare. 3. Three-limbed or triradiate spicules (with equal or unequal limbs and with equal or unequal angles), by far the most frequent, and at the same time the form most characteristic of the Calcispongiæ. 4. Four-limbed or quadriradiate spicules (the fourth ray of which usually projects freely into the canal-system). The different modifications of these four fundamental forms, which have hitherto occupied the attention of the observers of the Calcispongiæ more than all the rest of their organization, will be completely described in my monograph.

That the Calcispongiæ of all living sponges are most nearly allied to the corals, may be inferred in the first place even from the calcareous nature of the skeleton in the two groups. But to this may be added very interesting homologies in the special differentiation of the canal-system in the most highly developed forms of the Calcispongiæ, which in part directly approach the simpler forms of corals even by the formation of antimera*. We may therefore be allowed, in conclusion, to glance at *the steps in the evolution of the canal-system* in the Calcispongiæ.

At the root of the whole system (or, what is the same thing, of the genealogical tree) of the Calcispongiæ stands the remarkable *Prosycum*, the little calcareous sponge whose canal-system consists merely of a stomachal cavity with a mouth-opening. Next to this comes *Olynthus*, a simple "person" with stomach and mouth-opening, but the stomachal wall or body-wall of which is permeated by perfectly simple pores. These cutaneous pores are simple breaches in the parenchyma, which perforate

* Häckel applies the term "*antimera*" to the "homotypic organs" of Bronn—that is to say, to those segments of the body, placed side by side, of which each contains "all or nearly all the essential parts of the body of the species." The segments of the Radiate animals, as indicated in the text, furnish the most striking examples of this mode of formation. Where the repetition of parts occurs in consecutive segments (as in the Annulosa), these are called "*metamera*" by Häckel.—W. S. D.

both layers of the body-wall (ectoderm and entoderm) and are produced by the mutual separation of the cells at changeable points. There is no special canal-wall. *The situation and number of the cutaneous pores are not constant, but changeable,* in *Olynthus* and the most nearly allied Calcispongiæ (*Leucosolenia*, *Clistolynthus*). New ones form themselves, whilst the previously formed pores are again obliterated by the union of the cells which have moved asunder. The pores behave in this manner also in *Leucosolenia* (a stock-forming *Olynthus*) and in *Clistolynthus* (an *Olynthus* with the mouth closed up).

In the larger and more highly developed Calcispongiæ the simple and inconstant cutaneous pores gradually become converted into permanent and constant canals, which acquire a proper wall by the extension of the flagellate epithelium of the stomachal cavity upon their inner surface throughout the whole of the ectoderm (as in the family Sycaridæ). Among these the genera *Sycum* and *Dunstervillia* have hitherto been most accurately examined; and in these the cutaneous pores have become developed into very considerable canals, which are quite regularly arranged, and traverse the wall of the body in a radiating direction. All previous observers, however, have overlooked the fact that these *radiating canals* not only open inwardly into the stomach and outwardly at the surface of the body, but also all stand in direct communication with each other. The walls between the individual closely contiguous radiating canals are, in fact, perforated in all parts like a sieve, and interrupted by numerous apertures of communication, or *conjunctive pores*, through which each canal communicates with all its neighbours. In some genera the regular radiating canals ramify outwards in the same way as the irregular parietal canals in the walls of the Dyssycidæ.

The most remarkable development of the canal-system is attained, however, in *Cyathiscus*, which is nearly allied to *Sycarium* and *Sycum*, and in which the *horizontal* partitions between the *superimposed* radiating canals become absorbed, whilst the *vertical* partitions between the canals *lying side by side* persist. By this means is produced a *system of radial perigastric chambers*, which is exactly analogous to the corresponding system of perigastric cavities radially surrounding the stomach in the corals. The only distinction is, that the direct communication between the stomachal cavity and the chambers surrounding it takes place in the corals by the opening of the stomach and perigastric chambers below into the common basal space of the body-cavity situated beneath them, in *Cyathiscus*, on the contrary, by longitudinal rows of apertures (stomachal pores) which perforate the partition between the stomachal cavity and each perigastric radial chamber. *Thus the "person" of* Cyathiscus *divides into a radial system of antimera, just like each developed coral-person.*

That the *formation of antimera* occurs frequently in the sponges generally, and that thereby a still closer approximation to the corals is effected, has hitherto been entirely overlooked, Miklucho having only last year called attention to it (*l. c.* p. 230). In *Axinella polypoides*, *Osculina polystomella*, and many other sponges—among fossil forms, especially in *Cœloptychium lobatum*, *Siphonia costata*, &c., they strike one at once. These "radial" sponges are true "Radiata" no less than most corals. It is evident, however, that, from a tectological point of view, the sponges in which antimera are so distinctly differentiated rise no less than the more highly developed corals above the lower sponges, in which no formation of antimera occurs.

Consequently, except the higher degree of histological differentiation in most corals, there remains not a single character which completely separates the sponges from the corals. Even the tentacles surrounding the mouth, which have hitherto appeared to be the exclusive property of the corals, begin their development in certain sponges. At least I would regard as *incipient tentacles* the extremely remarkable curled and fringed "papillæ" which form a circlet surrounding the mouth-opening of *Osculina polystomella*, one of the most remarkable of sponges. Moreover less importance is to be ascribed to the tentacles of the corals, as secondarily developed appendages, because even corals occur in which they are almost wanting or developed only in the form of rudimentary buttons (e. g. *Antipathes*).

That the conditions of *stock-formation* or *cormogeny* are exactly the same in the corals and in the sponges scarcely needs to be particularly mentioned. It is precisely in this respect that the agreement between the two classes is so striking that it was this principally which led the older naturalists to unite the sponges and corals in their classifications. In the sponges we find no less multiplicity than in the corals in the combination of the "persons" to form stocks; and even the special modifications in the stock-formation which are produced by the multifarious forms of incomplete division and gemmation in the corals are reproduced in the sponges. Only one peculiarity pertaining here may be specially indicated, because it has repeatedly led to singular misinterpretations. This is the formation of peculiarly reduced stocks by the *growing together or concrescence of the branches*, i. e. "*persons.*" Just as in the well-known fan-corals (e. g. *Rhipidogorgia flabellum*) the peculiar forms of the flatly dilated net-like stocks are produced by the repeated concrescence of the branches and anastomosis of their cavities, so in the sponges there are found stocks not only dilated and reticulated, but even twisted up into a coil, whilst at the same time their branches, *i. e.* "persons," grow together and anastomose at their points of contact. Among the Calcispongiæ these labyrinthic coils become so dense, especially in the *Nardopsidæ* and *Tarromidæ*, that the interspaces between the adult "persons" have been frequently taken for the internal cavities of their communicating canal-system. Thus, for example, Kölliker describes the interstices and fissures between the densely united branches of the stock of his *Nardoa spongiosa* (our *Tarrus spongiosus*) as "efferent canals," and the internal vibratile canal-system (the cavities of the branches) which occurs in this as in many other sponges, as "a network of ciliated canals, such as has hitherto been seen in no sponge."

The most remarkable results are produced by continued concrescence of the "persons" in the genera *Nardoa*, *Nardopsis*, and *Cœnostoma*, which I have therefore comprised in the distinct order of the Cœnosyca. In these, after the attainment of maturity, the stomachal cavities or "flues" of the different "persons" which compose a stock, and which have been produced by lateral gemmation from one "person," open together finally into a single cavity (a common "excurrent tube") which opens outwards by a single orifice (a common mouth). As the mature sponge in this case possesses only a single mouth-opening, *it is apparently only a single "person," but in reality a true stock*, i. e. a cormus composed of several "persons." In youth each "person" possesses a proper mouth-opening, until it subsequently becomes united with its neighbours, and forms, together with these, a common mouth-opening.

If we are to distinguish these wonderful animal-stocks the "persons" of which, by excessive centralization, have given up the most essential part of their individuality, the mouth, and in place of it have acquired a common stock-mouth (*cormostoma*), from the primitive polystomatous cormi, by a particular denomination, they might perhaps be fittingly named *Cœnobia*. The oldest form of starfish (*Tocastra*), which, according to my hypothesis as developed in the 'General Morphology,' is also the primitive stem-form of the Echinodermata, would have to be regarded as a cœnobium of this kind. If, in accordance with this phylogenetic hypothesis, the primitive form of starfish actually represented a stock of annulated worms (persons) which had formed for themselves a common mouth-opening, this apparently so wonderful process would not, in fact, be more wonderful than the production of the cœnobium of a *Nardoa* or *Nardopsis* from a stock of *Leucosolenia*, which may at any time be traced ontogenetically. Thus the lower cœnobia of the Cœnosyca appear actually well fitted to elucidate the production of the higher cœnobia of the much more perfect Echinodermata.

Peculiar as the *Nardopsidæ* and *Cœnostomidæ* with their single cormostome may appear, they (or at least the former) are united by transitive intermediate forms with the *Leucosoleniæ* from which they have proceeded. Such transitive forms are the *Tarromidæ*, in which the sponge-stock possesses not one, but several cormostomes, and in which, therefore, the mouth-openings of the "persons" are not all fused together into one, but in groups into several separate stock-mouths. On the other hand, however, the advancing amalgamation of the mouth-openings originally present may lead to their complete disappearance, as in the astomatous sponges already cited. Both the individual "persons" (*Clistolynthus*) and the stocks composed of several "persons" (*Auloplegma*) may lose their original mouth-openings by secondary fusion. Hence there are among the Calcispongiæ both individual forms with cutaneous pores, but without a mouth (*Clistolynthus*, *Auloplegma*), and also opposite forms with a mouth but without cutaneous pores (*Prosycum*).

The phenomenon here touched upon, namely, that the apparently opposite and extreme structures are united by the interposition of a chain of gradual transition-forms, and that consequently the unity of the type of organization, *i. e.* the unity of descent, displays itself throughout, notwithstanding the greatest multifariousness in the details, strikes the critical and unprejudiced naturalist everywhere among the Calcispongiæ, as, indeed, among the sponges generally; and this causes their study to appear so extremely instructive and so uncommonly fruitful, especially for the understanding of the *descendence theory*. *The entire natural history of the sponges is a coherent and striking argument "for Darwin."* Fritz Müller and Oscar Schmidt have already put forward many particular examples of this undeniable fact, and I have myself everywhere found it perfectly confirmed. The organism of the sponges has evidently kept itself, down to our time, so fluid, so mobile, and so flexible, that we may here most plainly trace step by step *the origin of the different species from a common stem-form.*

In this respect two forms of sponges may be indicated as quite peculiarly instructive and interesting. These are Miklucho's *Guancha blanca* and my *Sycometra compressa*: these two calcareous sponges occurring in such various forms that they seem to belong sometimes to one and sometimes to another systematic group, and place systematists in the greatest difficulty. In the following Prodromus of a system of the Calcispongiæ* I have been able to get over this difficulty only by founding for them a special order—that of the Metrosyca.

Guancha blanca (from the Canary Islands), in its most developed form, appears as *a sponge-stock which bears on one and the same cormus the mature forms of not fewer than four perfectly different genera*, namely, *Olynthus* among the Monosyca (form A of Miklucho), *Leucosolenia* (form B) and *Tarrus* (form D) among the Polysyca, and *Nardoa* among the Cœnosyca (Miklucho's form C). In the same way, the most developed form of the Norwegian *Sycometra compressa* appears as *a sponge-stock which bears on one and the same cormus the mature forms even of eight different genera*, namely :—*Sycarium* and *Artynas*, of the family Sycaridæ; *Sycidium* and *Artynium*, of the family Sycodendridæ; *Sycocystis* and *Artynella*, of the order Clistosyca; and *Sycophyllum* and *Artynophyllum*, of the order Cophosyca. But we must regard all these forms united upon one stock as generically different, and not as mere developmental stages of one species, inasmuch as each of them is capable of reproduction, and bears about it in its *developed spores* the convincing *testimony of perfect maturity. In these extremely remarkable and important sponges the organic species is to be observed as it were "in statu nascenti."*

The same is probably true of *Sycarium rhopalodes* from Norway and *Ute utriculus* from Greenland, the latter described by Oscar Schmidt, provided that the different forms of these which I have ranged under the genera *Sycarium*, *Artynas*, *Sycocystis*, and *Artynella* really manifest their specific maturity by the possession of developed spores.

If we return, in conclusion, to the relation between the sponges and corals, and endeavour to establish *artificially* the boundary between these two classes of animals, we find nothing essential except the higher degree of histological differentiation in the corals, and especially their possession of urticating cells. *No sponge forms urticating organs in the cells of its ectoderm, whilst these are present* to a greater or less extent *in all Acalephs* (in all *Corals*, *Hydromedusæ*, and *Ctenophora* without exception). It must be admitted that this histological character is in itself very unimportant, and, in respect of both its physiological and its morphological significance, is but little adapted for the establishment of a sharp boundary

* A translation of this will appear in our next Number.

between the sponges and the other Cœlenterata. This boundary appears to be very artificial, if we consider that both among the Vermes and among the Mollusca there are particular forms with urticating organs. It is, however, still further weakened when we take a general view of the whole of the conditions of histological differentiation in the sponges and corals, and become convinced that in both classes a wide scope is given to the degree of differentiation. Not a few of the more highly developed sponges, with regard to histological differentiation, perhaps occupy a higher grade than many corals, or at least than the *Hydræ* among the Acalephs. On the other hand, a very important and thoroughgoing difference between the Acalephs and Sponges would result from the confirmation of the supposition expressed by me above, that zoospermia and consequently sexual differentiation do not occur among the sponges, and that the supposed "ova" of the sponges are agamic spores.

The further explanation and establishment of all the particulars here brought forward I reserve for my detailed monograph of the Calcispongiæ, and, in conclusion, beg all readers of this preliminary communication who may be in possession of dried or spirit specimens of Calcispongiæ to be kind enough to transmit them to me for examination and comparison, in order to render the systematic part of that work as complete as possible. The Calcispongiæ have hitherto been so sparingly represented in zoological collections almost everywhere, and their classification is so imperfect, that the following Prodromus of a system of the Calcispongiæ must commence quite afresh. Moreover many Calcispongiæ are so very different in their internal structure, whilst their sober exterior appears almost the same, that the most accurate microscopic examination of all the forms hitherto discovered is quite indispensable for the establishment of their classification.

XIV.—*On a new Genus of the Madreporaria or Stony Corals* (Stenohelia). By Wm. S. Kent, F.Z.S., F.R.M.S., of the Geological Department, British Museum.

In the 'Proceedings of the Zoological Society for 1862,' p. 196, J. Y. Johnson described as a new species of *Allopora* a small branching coral, of the family Oculinidæ, taken by himself in the vicinity of Madeira. There are, however, several points of structure connected with it, seemingly overlooked by Mr. Johnson, which render it perfectly essential that a new genus should be created for its reception.

The following are the characteristics of the new genus (for which I propose the name of *Stenohelia*), amended by recent observation:—

Corallum dendroid, flabelliform; surface of the cœnenchyma delicately striate. Calices all turned one way, pedunculate, compressed transversely to the axis of their peduncles. Septa equal, scarcely exsert. Columella styliform, deeply immersed. Pali rudimentary. Calicular fossa deep. Increasing somewhat irregularly by alternate distichal or subdichotomous gemmation. Ampullæ not essential, developed to a more or less considerable extent.

Stenohelia maderensis.

Allopora maderensis, J. Y. Johnson, Proc. Zool. Soc. p. 196, figs. 1, 2, 3, p. 197 (1862).

Corallum flabellate, the main stem somewhat irregularly and the ultimate ramifications alternate-distichal or dichotomously branching, occasionally, however, as many as three calices originating from the margin of the preceding one. Branches cylindrical, delicately striate, sometimes coalescing. Calices compressed, transversely ovate, pedunculate, all directed the same way, those on the main stem becoming gradually obscured by the outgrowth of the cœnenchyma. Septa scarcely exsert, twelve to sixteen in number, projecting but little into the calicular fossa. Calicular fossa very deep, having springing from its bottom a well-developed, styliform, pointed, and hirsute columella, surrounding which are traces of rudimentary pali. Ampullæ present in the shape of rounded elevations of the cœnenchyma studding the corallum on the opposite side to that on which the calices open, the surface of these elevations slightly echinulate. Long diameter of the calices measuring from $\frac{1}{20}$ to $\frac{1}{10}$ inch, the shorter averaging one-half of the same. Height of corallum of the single specimen in the British Museum $3\frac{1}{2}$ inches. Colour of the sclerenchyma pure opaque white.

Hab. Madeira.

The foregoing description differs essentially in two points from that given by Mr. Johnson,—in the first place, in the record of a well-developed columella, and, secondly, in that of the presence of ampullæ, both of which characters appear to have been entirely overlooked by the last-named writer. The columella, though deeply immersed and scarcely apparent, in every instance, to the unassisted eye, is very readily discernible with the aid of the pocket lens, the assistance of a low power of the compound microscope, however, being requisite to define its hirsute character. The ampullæ, though sparingly scattered, are occasionally nearly globular, and of a size almost equalling in diameter that of the ramuscules which support them.

Mr. Johnson, in describing the species as *Allopora maderensis*, considers it to possess a great general resemblance to *Stylaster flabelliformis*, and, being under the impression that it does *not* possess ampullæ, is of the opinion that this last circumstance indicates that the two genera *Allopora* and *Stylaster* should be united. Admitting the insufficiency of the presence or absence of these episclerenchymatous developments as a generic or even specific diagnostic (which fact I shall amply demonstrate in describing some new species of *Allopora* proper in a forthcoming catalogue of the Madrepores contained in the British Museum, now in course of publication), the alternate-distichal or entirely irregular nature of the gemmation which obtains in the two respective genera is alone an all-sufficient line of demarcation; and accordingly, of these two, Mr. Johnson's species is the more closely allied to *Stylaster*.

Mr. Johnson, again, suggests that this species may possibly be identical with the *Allopora infundibulifera* of Lamarck. Specimens of the last-named species in the National collection, however, prove it to be very distinct from that interesting form.

With regard to the true zoological affinities of *Stenohelia*, the pedunculated and transversely ovate calices all turning the same way, and the subdichotomous mode of gemmation frequently evinced, seem rather to indicate its close relationship to *Cryptohelia* of the West-African coast; it is, moreover, a remarkable and significant fact that in many instances the lower half of the calyx is as it were thrust in upon the calicinal fossa; and this may be accepted as a disposition towards the extreme modification in the same region which obtains in that genus, where we find that the inferior half is folded back so as to entirely conceal the calicular fossa. The close proximity of the habitats whence these two genera have been procured also carries with it a highly important significance.

The genus *Endohelia* of Milne-Edwards may possibly form the immediate intervening link connecting the two genera here compared. It is distinguished by having the inferior edge of the calices developed in a tongue-like form in front of the orifices, though to a less extent than in *Cryptohelia*; the surface of the cœnenchyma is smooth, and both columella and pali are deficient.

Stenohelia complanata.

Stylaster complanatus, Pourtales, Bulletin Mus. Comp. Zool. Cambridge, U. S. p. 115 (1867).

This species very closely approaches the preceding, and, except for its minute size, is scarcely distinguishable from it. Such was the opinion entertained on reading Pourtales's description; and a recent opportunity afforded me by Dr. Duncan, of consulting his type specimens, only confirmed me in the conclusion I had then arrived at.

XV.—*Notulæ Lichenologicæ.* No. XXXII.

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

The following Analytical Key is extracted from Dr. Ernst Stizenberger's "Monograph of *Lecidea sabuletorum*, Flörke, and the Lichens allied to it," in 'Acta Acad. Nat. Curios.' vol. xxxiv., and will be found serviceable to the student of that series of *Lecideæ* with fusiform spores.

1.	Spores 6–many-celled	2.
	Spores (2–)4-celled	27.
2.	Apothecia in section pale	3.
	Apothecia in section dark	20.
3.	Apothecia without margin	4.
	Apothecia with persistent or evanescent margin	12.
4.	Colour of apothecia constantly pale or varying from pale reddish to dark brown	5.
	Colour of apothecia constantly brown to black	9.
5.	Apothecia 0·3 millim. in diameter	6.
	Apothecia 0·5 millim. in diameter	7.
6.	Thallus leprose, pale; fruit grey to black. *L. cinerea*, Schær. (Exs., Hepp, 21).	
	Thallus powdery, sap-green; fruit yellowish. *L. cinerea*, f. *hypoleuca*, Stizb.	
7.	Spores 4 mik.* broad. *L. cupreo-rosella*, Nyl. (Mass. 211, A, B; Hepp, 512; Zw. 269, A; Arn. 265).	
	Spores 8 mik. broad	8.
8.	Paraphyses compacted. *L. sabuletorum*, f. *Killiasii*, Hepp.	
	Paraphyses free. *L. sabuletorum*, f. *subsphæroides*, Nyl.	
9.	Apothecia 0·3 millim. in diameter	10.
	Apothecia 0·4–0·6 millim. in diameter	11.
10.	Spores 40 mik. long. *L. chlorococca*, Græwe (Stenh. 170).	
	Spores 26 mik. long. *L. chlorococca*, v. *brachysperma*, Stizb.	
11.	Hypothecium pale. *L. sabuletorum*, v. *miliaria*, Fr. (Zw. 121; Leight. 210; Anzi, Langob. 148; Mudd, 156, 158; Rabh. 322, 603).	
	Hypothecium brownish. *L. sabuletorum*, v. *miliaria*, f. *scoliciosporioides*, Bagl.	

[* The "mik." probably = $\frac{1}{20000}$ of an inch.]

12. Apothecia constantly red . . . . 13.
Apothecia deep brown to black . . . . 16.

13. Hypothecium pale . . . . 14.
Hypothecium brownish red . . . . 15.

14. Spores 34–50 mik. long. *L. sarcion*, Stizb. (*pleistomera* olim).
Spores 15–30 mik. long. *L. cupreo-rosella*, Nyl.

15. Apothecia 0·5 millim. broad. *L. prasino-rubella*, Nyl.
Apothecia 1 millim. broad. *L. Audita*, Nyl.

16. Spores 6-celled, exceptionally under 4-celled. *L. Naegelii*, Hepp (Hepp, 19; Anzi, Langob. 167, 379, *id.* Ven. 58; Rabh. 535, 536, 602; Zw. 87, A, C, 396), and *L. sabuletorum*, v. *obscurata*, Sommf. (Anzi, Langob. 166).
Spores normally 6–many-celled . . . . 17.

17. Hypothecium pale . . . . 18.
Hypothecium brown . . . . 19.

18. Apothecia 0·3 millim. in diameter, with persistent pale margin. *L. cyrtelloides*, Nyl.
Apothecia 0·5–0·8 millim. in diameter, with evanescent margin. *L. effusa*, Auersw. (Rabh. 32).

19. Apothecia 0·5–1 millim. in diameter. *L. sabuletorum*, Flk. (Schær. 474; Hepp, 138, 139; Leight. 91; Mudd, 154; Rabh. 534, 601, 625; Arn. 295; Zw. 84, 193; Anzi, It. S. 259, B).
Apothecia 0·3–0·5 millim. in diameter. *L. sabuletorum*, f. *ludens*, Nyl.

20. Apothecia without margin . . . . 21.
Apothecia with evanescent or persistent margin . . . . 24.

21. Spores under 30 mik. long . . . . 22.
Spores above 30 mik. long . . . . 23.

22. Apothecia 0·5 millim. in diameter; spores $2\frac{1}{2}$–4 times as long as broad. *L. comparanda*, Nyl.
Apothecia 0·3 millim. in diameter; spores $4\frac{1}{2}$–5 times as long as broad. *L. quintula*, Nyl.

23. Spores under 40 mik. long. *L. sabuletorum*, v. *miliaria*, f. *scoliciosporioides*, Bagl.
Spores 40–70 mik. long. *L. sabuletorum*, v. *decedens*, Hepp (Arn. 233).

24. Hymenium tinted blue by iodine . . . . 25.
Hymenium tinted yellow or violet by iodine . . . . 26.

25. Thallus leprose. *L. diploiza*, Nyl.
Thallus scurfy. *L. sabuletorum*, v. *syncomista*, Flk. (Hepp. 280; Arn. 77, 183; Anzi, Langob. 165).

26. Epithecium blue-green; spores narrow. *L. sabuletorum*, v. *syncomista*, f. *apatela*, Hepp.
Epithecium pale olive-colour; spores broad. *L. sabuletorum*, f. *atrior*, Stizb.

27. Apothecia in section dark . . . . 28.
Apothecia in section pale . . . . 45.

28. Spores over 20 mik. long . . . . 29.
Spores at most 20 mik. long . . . . 34.

29. Apothecia with evanescent or persistent margin, 0·8–1·5 millim. in diameter . . . . 30.
Apothecia without margin, 0·7 millim. in diameter . . . . 31.

30. Hymenium tinted blue by iodine. *L. triseptata*, Hepp.
Hymenium tinted vinous yellow by iodine; spores 21 mik. long. *L. chytrina*, Stizb.
Hymenium tinted violet by iodine; spores 30 mik. long. *L. sabuletorum*, v. *syncomista*, f. *fusispora*, Hepp.

31. Hypothecium black-brown .... 32.
Hypothecium pale or in some part brownish .... 33.

32. Hymenium violet or blue, above brown. *L. melana*, Nyl. (M. & N. 1329; Mudd, 159; Fellm. 159; Anzi, It. S. 259).
Hymenium pale, above blue-green or brownish. *L. sabuletorum*, v. *syncomista*, f. *montana*, Nyl. (Schær. 194 pp.)

33. Epithecium blue-green. *L. sabuletorum*, v. *syncomista*, f. *holomela*, Nyl.
Epithecium and hypothecium pale brown. *L. sabuletorum*, v. *obscurata*, f. *artyta*, Ach.
Epithecium dark brown; hypothecium pale. *L. sabuletorum*, v. *obscurata*, f. *epimelas*, Stizb.

34. Apothecia with margin .... 35.
Apothecia with evanescent margin .... 36.
Apothecia with persistent margin .... 41.

35. Hypothecium colourless. *L. thysanota*, Tuck.
Hypothecium dark; spores 13 mik. long. *L. sororiella*, Nyl.
Hypothecium dark; spores over 13 mik. long. *L. melana*, Nyl.

36. Apothecia 1 millim. in diameter .... 37.
Apothecia 0·5 millim. in diameter .... 38.

37. Hypothecium pale. *L. byssomorpha*, Nyl.
Hypothecium red-brown; hymenium tinted wine-red by iodine. *L. trachona*, v. *coprodes*, Körb.
Hypothecium red-brown; hymenium tinted blue by iodine. *L. micromma*, Nyl. (Arn. 282).
Hypothecium brown-black. *L. sabuletorum*, v. *syncomista*, f. *melancholica*, Stizb.

38. Apothecia permanent black; thallus scurfy. *L. sabuletorum*, v. *syncomista*, f. *gamora*, Stizb.
Apothecia permanent black; thallus finely granular. *L. sabuletorum*, v. *syncomista*, f. *Templetoni*, Tayl.
Apothecia with colour changeable into black .... 39.

39. Hymenium with free paraphyses. *L. phæomela*, Nyl.
Hymenium pale violet, with compact paraphyses. *L. trachona*, f. *fragilis*, Kremp.
Hymenium colourless, with brown epithecium and compact paraphyses .... 40.

40. Apothecia 0·2–0·3 millim. in diameter. *L. pinguicula*, Bagl.
Apothecia 0·5 millim. in diameter. *L. trachona*, Ach. (Zw. 104, 117).

41. Apothecia 1 millim. in diameter .... 42.
Apothecia 0·5 millim. in diameter .... 44.

42. Apothecia permanently flat. *L. artytoides*, Nyl.
Apothecia ultimately convex .... 43.

43. Spores 21 mik. long, plain. *L. chytrina*, Stizb.
Spores 17 mik. long, constricted. *L. chytrina*, v. *hormospora*, Stizb.

44. Apothecia 0·2 millim. broad, brown. *L. mesomela*, Nyl.
Apothecia 0·3–0·5 millim. broad, brown. *L. leucoblephara*, Nyl.
Apothecia 0·5 millim. broad, black. *L. trachona*, f. *marginatula*, Nyl.

45. Hymenium tinted blue by iodine .... 46.
Hymenium tinted violet or vinous-yellow by iodine .... 57.

46. Spores nearly acicular. *L. cupreo-rosella*, Nyl.
Spores elliptical, kidney-shaped, or fusiform .... 47.

47. Apothecia without margin .... 48.
Apothecia with evanescent or persistent margin .... 52.

48. Apothecia permanently brown-black or black .... 49.
Apothecia variable in colour .... 51.

49. Apothecia very small; paraphyses free-branched. *L. Nitschkeana*, Lahm (Rabh. 583 pp.; Arn. 217).
Apothecia large; paraphyses compact or indistinct .... 50.

50. Apothecia flat; hymenium blue-green above. *L. allotropa*, Nyl.
Apothecia hemispherical; hymenium blue-green above. *L. sabuletorum*, v. *miliaria*, f. *trisepta*, Naeg. (Hepp, 20, 284, 285; Zw. 276; Körb. 133; Leight. 238; Hepp, 510 (non Leight. 210); Arn. 167; Mudd, 157).
Apothecia hemispherical; hymenium brown-black above. *L. sabuletorum*, v. *obscurata*, f. *epimelas*, Stizb.

51. Apothecia grey; hypothecium colourless. *L. Naegelii*, f. *occulta*, Stizb.
Apothecia red-brown; hypothecium colourless. *L. Naegelii*, v. *obscuriuscula*, Nyl.
Apothecia red-brown to brown, within flesh-coloured. *L. sabuletorum*, v. *obscurata*, f. *microcarpa*, Th., Fr.

52. Apothecia over 0·5 millim. in diameter .... 53.
Apothecia under 0·5 millim. in diameter .... 54.

53. Spores 30 mik. long; thallus finely granular, thin. *L. sabuletorum*, v. *obscurata*, Sommf. (Anzi, Langob. 166; Hepp, 11 pp.; Zw. 193 pp.).
Spores 30 mik. long; thallus verrucoso-scurfy. *L. sabuletorum*, v. *obscurata*, f. *leucorhypara*, Nyl.

54. Spores at most 20 mik. long .... 55.
Spores above 20 mik. long .... 56.

55. Margin persistent. *L. trachona*, v. *Notarisiana*, Bagl.
Margin evanescent. *L. trachona*, Ach.

56. Spores narrow, 4 mik. broad; epithecium colourless. *L. sabuletorum*, v. *obscurata*, f. *venusta*, Hepp.
Spores broad, 6 mik. and more; epithecium yellowish or brown. *L. Naegelii*, Hepp.

57. Apothecia without margin .... 58.
Apothecia with evanescent or persistent margin .... 62.

58. Apothecia black, small. *L. Nitschkeana*, Lahm.
Apothecia black, large. *L. sabuletorum*, v. *miliaria*, f. *simplicior*, Nyl.
Apothecia pale .... 59.

59. Apothecia flat; paraphyses none. *L. metamorphea*, Nyl.
Apothecia slightly convex; paraphyses compact .... 60.

60. { Thallus nearly wanting. *L. sphæroides*, f. *peralbata*, Nyl.
Thallus powdery. *L. sphæroides*, f. *microbola*, Ach.
Thallus verrucoso-granulate .... 61.

61. { Spores 24 mik. long. *L. sphæroides*, f. *leucococca*, Nyl.
Spores 19 mik. long. *L. cupreo-rosella*, v. *chloroticoides*, Nyl.

62. { Apothecia 0·8–1 millim. in diameter........................ 67.
Apothecia at most 0·7 millim. in diameter .... 63.

63. { Apothecia constantly dark. *L. sabuletorum*, v. *miliaria*, f. *sphæralis*, Fr.
Apothecia pale or gradually darkened .... 64.

64. { Paraphyses wanting or deliquescent .... 65.
Paraphyses nearly free .... 66.

65. { Hymenium at first tinted blue, then violet, by iodine. *L. rufidula*, Græwe.
Hymenium at first tinted blue, then vinous yellow, by iodine. *L. sphæroides*, f. *epixanthoides*, Nyl.

66. { Spores 4–5 times as long as broad. *L. cupreo-rosella*, v. *fuscoviridis*, Anzi (Anzi, Langob. 403).
Spores 2½–3½ times as long as broad. *L. sphæroides*, v. *tylocarpa*, Nyl.

67. { Apothecia gradually darkened into black .... 68.
Apothecia constant pale yellow or red-brown................ 70.

68. { Corticolar. *L. sphæroides*, f. *versatilis*, Nyl.
Saxicolar .... 69.

69. { Spores 20 mik. long. *L. cupreo-rosella*, v. *fuscoviridis*, f. *hygrophila*, Stizb. (Arn. 20).
Spores 30 mik. long. *L. sabuletorum*, v. *obscurata*, f. *muricola*, Nyl.

70. { Apothecia sessile. *L. sphæroides*, Dicks. (Fellm. 158; Anzi, Langob. 261; Hepp, 513; Schær. 207 pp.; Zw. 277).
Apothecia substipitate, pale below. *L. sphæroides*, v. *substipitata*, Nyl.

BIBLIOGRAPHICAL NOTICES.

Flora Europæa Algarum aquæ dulcis et submarinæ. Auctore Ludovico Rabenhorst, Philos. Dr., Ordinis Albrecht. Equite, Acad. et Societ. plur. Sodali.

The completion of Dr. Rabenhorst's work upon the European freshwater Algæ cannot fail to be acceptable to those botanists who have directed their attention to these much-neglected and ill-understood organisms. The advance which has been made during the last twenty years in the knowledge of these plants has almost rendered obsolete what had previously been written upon the subject. In England there is literally no work sufficient for students of freshwater Algæ. The 'English Flora,' Dillwyn and Greville, must now be looked upon as antiquated, and Hassall and Harvey's 'Manual' as out of date. The great work of the latter author, viz. the 'Phycologia Britannica,' is limited to marine species. Mr. Berkeley's 'Introduction to Cryptogamic Botany' abounds with interesting remarks upon various genera, but does not profess to systematize lower than orders. The treatises of Mr. Ralfs and of the late Professor Smith have deservedly acquired a classical reputation; but they are only monographs of special families. There is an immense amount of accurate information scattered through the pages of the 'Micrographic Dictionary,' which, if collected, arranged, and somewhat amplified, would go a long way towards supplying the deficiency. Dr. Gray's useful 'Handbook' is only intended as a catalogue to assist in the arrangement of Algæ for the herbarium, and does not contain any specific characters.

It is therefore a great satisfaction to meet with a work which has gathered up the great mass of scattered information relative to the Algæ of Europe which inhabit fresh or brackish water; it affords a sort of resting-place from which to start afresh for the investigation of the numberless questions which still remain to be determined with regard to the plants now under review. No one would be more ready than Dr. Rabenhorst himself to admit that his work, valuable as it is, is far from exhaustive of the subject. As regards one great tribe, his *Phycochromophyceæ*, he himself remarks that our knowledge is still "valde imperfecta et manca;" and indeed it may be a question, as will be seen in the sequel, whether most of the genera of this division may not prove to be wholly inadmissible.

With these preliminary remarks, we will proceed to give some account of the contents of the work before us.

Dr. Rabenhorst (as is perhaps unavoidable in treating only of the freshwater Algæ) departs somewhat from the hitherto generally received classification. Instead of dividing the group into Chlorosperms, Rhodosperms, and Melanosperms, he constitutes five classes:—1. *Diatomophyceæ* (or *Diatomaceæ*); 2. *Phycochromophyceæ*; 3. *Chlorophyllophyceæ*; 4. *Melanophyceæ*; and 5. *Rhodophyceæ*. Of these, the three latter comprise such of the Algæ of the three divisions just mentioned as are not removed into the *Diatomophyceæ* and *Phycochromophyceæ*.

With regard to the first class (the *Diatomophyceæ* or *Diatomaceæ**), there will probably be few botanists who will object to their having a separate division assigned to them. Their very remarkable structure, their mode of reproduction, their apparent want of immediate affinity with any other of the plants known as "Algæ," afford quite sufficient grounds for keeping them by themselves. They seem out of place amongst the Chlorosperms, to which they have been hitherto referred, and if removed from that division it would be impossible to do otherwise than to make them a class by themselves.

Dr. Rabenhorst divides the *Diatomaceæ* into fourteen families.

To go at any length into the discussion of these would occupy

* The term *Diatomophyceæ* has evidently only been adopted to preserve a kind of uniformity of nomenclature with the other four classes; but it is an awkward expression, and will certainly not be allowed to displace the well-known name "*Diatomaceæ*."

more space than can be allotted to the whole of this review; but comparing these "families" with the "cohorts" adopted by Professor Henfrey in the 'Micrographic Dictionary,' and with the "groups" of Mr. Carruthers * in Dr. Gray's 'Handbook,' we find little substantial difference.

With regard to the last family, the *Actiniscеæ*, it has been questioned whether any of the genera there included, viz. *Dictyocha*, *Actiniscus*, *Mesocena*, and *Eucampia*, ought to be included in the *Diatomaceæ*. *Dictyocha* and *Mesocena* have been supposed to be spicules of Echinodermata, and *Eucampia* has been placed by Kützing in the *Desmidiaceæ*, and by Smith in the *Diatomaceæ*. Dr. Rabenhorst admits that in habit and structure they differ widely from all *Diatomaceæ*, but he considers that, having regard to their siliceous covering, they ought not to be excluded from the class.

Dr. Rabenhorst's second class is the *Phycochromophyceæ*. It has been remarked above that there will probably be no objection raised to the separation of the *Diatomaceæ* from the other freshwater Algæ; but the same can hardly be said of the class *Phycochromophyceæ*, which can only be looked upon as temporary.

The nature of phycochrom is not yet very well understood. The term was invented by Nägeli in his 'Einzellige Algen,' where, after stating that in most of the unicellular Algæ the colouring-matter is chlorophyll, he says:—

"In other genera of unicellular Algæ, especially in the *Chroococcaceæ*, the cell-contents exhibit a peculiar colouring-matter.... It is usually bluish green (verdigris-green), very often orange or brick-red; sometimes it is violet- or copper-coloured, very rarely blue, yellow, or pure red."

Cohn, in speaking of the *Oscillarineæ*, says that the verdigris-green colouring-matter of these plants, the phycochrom of Nägeli, is a compound body, consisting of a green substance insoluble in water, but soluble in alcohol and ether, viz. *chlorophyll*, and of a substance (conversely) soluble in water and insoluble in alcohol and ether, which he calls *phycocyan*.

He says that, in living cells, both colouring-matters combine to form a compound colour, the phycochrom of Nägeli. Dr. Askenasy, in his papers in the 'Botanische Zeitung'†, discusses the remarkable optical properties (fluorescence and the bands of absorption produced in the spectrum) which are exhibited by chlorophyll, and by the colouring-matter of the *Florideæ*, of *Peltigera canina*, and of *Collema*; and at the conclusion of his remarks he says—

"With regard to the names phycochrom of Nägeli and rhodophyll ‡ of Cohn, I believe that they are now superfluous; for they signify

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* Mr. Carruthers's arrangement is that of Ralfs, with some modifications by Meneghini, Kützing, and others.

† "Beiträge zur Kenntniss des Chlorophyll und einigen dasselbe begleitender Farbstoffe," Bot. Zeit. July 19 & 26, 1867.

‡ Cohn's "rhodophyll" is the reddish-brown colouring-matter of the *Florideæ*.

nothing more than the mixture of chlorophyll with other various colouring-matters, whose peculiarities have hitherto only been satisfactorily ascertained in a few instances."

The tint of phycochrom is so easily distinguishable by the eye from the other colouring-matters of Algæ, that there is a temptation to combine together all those plants whose cells contain it; but the class (*Phycochromophyceæ*) can only be looked upon as provisional, as a sort of "refugium" for a vast number of heterogeneous organisms, few if any of which are really autonomous. It may not be without interest to go shortly through the orders and families into which the class is divided, and to call attention to some of the genera whose right to the designation of Algæ has been called in question.

Dr. Rabenhorst divides his *Phycochromophyceæ* into two orders, the *Cystiphoræ* and the *Nematogenæ*. The *Cystiphoræ* consist of one family, the *Chroococcaceæ*; and the *Nematogenæ* of five families, the *Oscillariaceæ*, the *Nostochaceæ*, the *Rivulariaceæ*, the *Scytonemaceæ*, and *Sirosiphonaceæ*.

With regard to the *Chroococcaceæ*, it is highly probable that many of the so-called genera of the family are nothing more than phases of the gonidia of lichens. This notion has been making progress lately; but its origin is not of very recent date. In one of the latest papers* on the subject, Dr. Itzigsohn gives the result of a series of observations on the culture of the gonidia of *Peltigera canina*. He says that the mode of growth observed in them identifies these gonidia entirely with the *Chroococcaceæ*, and that in the process of development he has seen them assume the forms of the genera *Glœocapsa*, *Glœothece*, and *Aphanothece*.

Again, Messrs. Famintzin and Boranetzky, in their observations in the 'Mémoires de l'Acad. de St. Pétersbourg' (which are to be found also in the 'Botanische Zeitung' for March 13, 1868, and in the 8th volume of the current series of the 'Annales des Sciences Naturelles'), have arrived at the conclusion that *Cystococcus* and *Polycoccus* (to say nothing of *Nostoc*) are only states of the gonidia of lichens. If this be true of *Cystococcus* and *Polycoccus*, it is hardly possible to doubt that the same will be eventually proved to be the case with such genera as *Aphanocapsa*, *Microcystis*, *Anacystis*, *Polycystis*, and *Cœlosphærium*, as also with *Homalococcus*, which consists of one species, the *Coccochloris hyalina* of Meneghini. It is hardly too much to say that *Gomphosphæria* is not generically distinguishable from *Glœocapsa*; and, considering what is now known, it may safely be asserted that no one would, at the present day, think of making a genus of *Chroococcus* or *Synechococcus*. With the above eliminations the family of the *Chroococcaceæ* would be reduced to the genera *Clathrocystis*, *Merismopædia*, and *Oncobyrsa*. *Clathrocystis* was established by Professor Henfrey in the 'Microscopical Journal' for 1855. He seems to have separated it from *Polycystis* only because that name

* Botanische Zeitung, March 20, 1868.

had been preoccupied in the Fungi, a reason which would not now be considered sufficient. Dr. Rabenhorst's definition tells the true tale of its origin, "*Polycystis* thallo gelatinoso, initio solido, *ætate provecta clathrato.*" It is, in fact, nothing more than a *Polycystis* the gelatine of which has become ruptured and perforated as it has advanced in age. Of *Merismopædia* it may be remaked that it is with difficulty, if at all, to be distinguished from *Sarcina* *; and if *Sarcina* (as some good authorities consider) is in reality not an alga but a fungus, the validity of the genus may not unreasonably be questioned. With regard to *Oncobyrsa* it appears (we have not the work to refer to) to have been placed by Meneghini amongst the *Nostochineæ*; and if this be correct, the genus can hardly be supported after the observations of many past years tending to show the connexion between *Nostoc* and the Collemaceous lichens.

It would be going into too much detail to discuss at any length the other five families of Dr. Rabenhorst's *Phycochromophyceæ*. Doubts may be entertained whether many (if any) of the genera of the *Oscillariaceæ* are autonomous, but they may reasonably be retained here in the absence of indications of closer affinities elsewhere. With regard to one of the genera, viz. *Lyngbya*, it has been stated that it does not oscillate, at least when in long filaments, which raises a doubt whether its proper position (assuming it be a good genus) is with the *Oscillariaceæ*. Dr. Hicks has suggested (Micr. Journ. n. s. vol. i. p. 164) that *Lyngbya muralis*, *Schizogonium*, and *Prasiola* are but different stages of the same organism; but it is doubtful how far this view can be supported; for the two latter are chlorophyllaceous Algæ, which would seem to render improbable any close connexion between them and *Lyngbya*, which is phycochromaceous †.

With regard to the *Nostochaceæ*, the discussions which have taken place as to their nature and affinities would fill a volume. It was long since suggested that most if not all of the plants usually placed in this family are only conditions of gelatinous lichens—an opinion which is now gaining ground, notwithstanding Mr. Berkeley's high authority on the other side, who says, in his 'Introduction to Cryptogamic Botany' (p. 141), that he cannot subscribe to this doctrine. Nylander is of opinion that the *Nostoc* of modern algologists, in part at least, if not entirely, may be regarded as the initial or metamorphic states of the *Collemata*; and he even goes further, and considers that he has added to the lichens various *Scytonemata* and *Sirosiphones*, such as *Synalissa picina*, *S. melodermia*, &c.‡

Dr. De Bary suggests a singular alternative theory, which is

* In the 'Botanische Zeitung' for January 10, 1868, Hallier states that *Sarcina* differs from *Merismopædia* in its mode of division.

† See some remarks by Mr. Archer in the Proc. Nat. Hist. Soc. of Dublin, vol. iv. p. 273.

‡ See 'Notulæ Lichenologicæ,' translated by Leighton in Ann. & Mag. Nat. Hist. for November 1868.

worthy of notice here. After discussing the question of relationship between the gelatinous lichens and certain Algæ, he says:—

"With these data it can hardly be doubted that a large proportion of the *Nostochaceæ* and *Chroococcaceæ* are closely allied to the gelatinous lichens, such as *Ephebe* &c. But the question as to the nature of the alliance remains to be investigated. If I might express my individual opinion, the reasons for which cannot here be given, I should say that two theories suggest themselves. Either the lichens in question are the fully developed fructifying states of plants whose immature forms have hitherto been placed amongst the Algæ, or the *Nostochaceæ* and *Chroococcaceæ* are typical Algæ and assume the forms of *Collemata*, *Ephebe*, &c., from the fact that certain parasitical *Ascomycetes* penetrate into them, distribute their mycelium into the growing thallus, and often become attached to the phycochromaceous cells of the former. In the latter case, the plants in question would be pseudo-lichens, similar to the Phænogams deformed by parasitic fungi, as, for instance, *Euphorbia degener* &c."

The family of the *Rivulariaceæ* is the most interesting of the six into which the class *Phycochromophyceæ* is divided. Much doubt still exists as to the real nature of the plants composing it; and in a recent well-known work, the 'Traité Général de Botanique,' by Le Maout and Decaisne, the family is swept away with a number of others under the title of *Algæ spuriæ*. Those eminent botanists say (*l. c.* p. 718):—

"We combine under the title of doubtful Algæ (*Algæ spuriæ*) a certain number of ill-known genera, which are probably only degraded types of the preceding families; these are the Algæ out of which have been formed the *Rivularieæ*, the *Oscillarieæ*, the *Nostochineæ*, the *Palmelleæ*, and the *Volvocineæ*."

Nevertheless several of the *Rivulariaceæ* are objects of great beauty, well deserving of careful study. Some of the so-called genera admitted by Dr. Rabenhorst appear rather too closely allied to one another; but perhaps, until more is known of them, it is safer and more useful to keep them distinct. Dr. Rabenhorst divides the family into two subfamilies—the *Rivularieæ*, distinguished by a rounded thallus which is either gelatinous or indurated, and the *Mastigotrichiæ*, with a thallus indefinitely expanded and often crustaceous. In the present imperfect state of our knowledge of the reproduction of these plants, it is impossible to speculate as to how far any of the proposed genera will be permanent*.

The *Scytonemaceæ* form the fifth family of this class. Most of the genera arranged in it have hitherto been classed with the *Oscillariaceæ*. Some are remarkable for the peculiarity of the mucous sheath in which the filaments are enveloped; for instance, the interrupted sheath of *Drilosiphon* and the feathered covering of *Arthrosiphon* (or *Petalonema*) are objects worthy of the careful

* With regard to one of the genera, *Inomeria*, which is described by Dr. Rabenhorst as "admodum dubium," the reader should consult a paper in the Ann. d. Sc. Nat. 5e sér. vol. vi., "Recherches sur l'organisation du genre *Inomeria*, Kg.," by M. Ripart.

attention of microscopic observers. It would be interesting to follow the development of such genera as *Drilosiphon* and *Schizothrix*, and trace the changes in the mucous envelope from the early to the mature state of the plants.

The sixth and last family of the *Phycochromophyceæ* is the *Sirosiphonaceæ*. Omitting *Stigonema* as a genus "incertæ sedis," it consists of but four genera. Of these, *Mastigocladus* forms a spongy stratum, and *Fischera* a gelatinous one, in hot baths in Italy. *Hapalosiphon* is the *Polypothrix* of Kützing, from which it has been separated on account of its mode of ramification, which is supposed to point to a higher grade of evolution. The remaining genus is *Sirosiphon* or (as it ought perhaps to be called) *Hassallia*, remarkable for its multiseriate glœocapsoid cells. *Sirosiphon*, as well as the genera of the *Scytonemaceæ* above alluded to, was formerly placed with the *Oscillatoriæ*; and Mr. Berkeley, in his 'Introduction to Cryptogamic Botany,' remarks of it:—

"It may perhaps be doubted whether any of the species of *Sirosiphon*, beautiful as they are, are autonomous. At any rate, their mode of growth and ramification are totally different from those of other *Oscillatoriæ*. It is a single endochrome which bursts through the investing tube and constitutes a branch, a character by which the species are at once known from *Scytonema*."

Dr. De Bary, in the second volume of Hofmeister's 'Handbuch der physiologischen Botanik,' speaks more decidedly. He says (p. 291) that the thin branches of the thallus of *Ephebe pubescens* represent typical forms of the genus *Sirosiphon*, that true and unquestionable examples of *Sirosiphon* occur in the tufts of *Ephebe*, and that it may often be seen that they spring like branches from the threads of the *Ephebe*.

We come now to Dr. Rabenhorst's third class, the *Chlorophyllaceæ*. These he divides into four orders, the *Coccophyceæ*, *Zygophyceæ*, *Siphophyceæ*, and *Nematophyceæ*. The *Coccophyceæ* contain the families *Palmellaceæ*, *Protococcaceæ*, and *Volvocineæ*. Many of the genera in the first two families have been subjected to the same objections as have been raised against so many of the genera in the *Chroococcaceæ*, viz. that they are not autonomous, but only states of higher Algæ, or perhaps of the gonidia of lichens. Nevertheless (with perhaps one or two exceptions) it will probably be thought that Dr. Rabenhorst has done well in not reducing the number of genera; for although many may hereafter prove to be not maintainable, it would as yet be premature to make any considerable reduction. The present status of several of these genera is very appropriately stated by Mr. Archer, in some remarks which occur in a paper on Palmoglœan Algæ, in the fourth volume of the 'Proceedings of the Natural-History Society of Dublin.' Mr. Archer is combating the views of Dr. Hicks, whom he seems to suspect of wishing to abolish the *Palmellaceæ* in a body. He (Mr. Archer) says:—

"Many of the Palmellacean genera produce a very definite structure, even what may be called a frond, and sometimes very definite forms of the individual cells themselves.

"So readily do these specialities strike the eye, when once they have been seen, that, on their recurrence, they are at once recognizable. The generic names *Apiocystis*, *Schizochlamys*, *Palmodactylon*, *Tetraspora*, *Monostroma* (*Ulva*, in part), *Dictyosphærium*, *Oocardium*, *Hormospora*, *Nephrocytium*, *Mischococcus*, *Ankistrodesmus* (*Rhaphidium*), *Polyedium*, *Cystococcus*, *Dactylococcus*, *Characium*, *Ophiocytium*, *Scenedesmus*, *Pediastrum*, *Cœlastrum*, *Sorastrum*, *Eremosphæra*, and many more, all call to mind, in a moment, forms which, some rarely, some frequently, present themselves to notice, maintain their characteristics while at the same time no true generative process has been discovered, and reproduce themselves by diverse modes of cell-division, by zoospores, by 'brood-families,' &c. They are also found maintaining their characters in various places; and I think it is not readily conceivable what varied accidental concatenation of circumstances could, in so diverse localities, force a certain supposed gonidium of a lichen, or spore of a moss, now to develope into this well-defined form, now into that. Therefore, if, on the one hand, such genera, perhaps, as *Chroococcus*, *Glœocapsa*, *Synechococcus*, *Glœothece* (in *Chroococcaceæ*), and *Pleurococcus*, *Glœocystis*, and *Palmella* (in *Palmellaceæ*) seem, from Dr. Hicks's researches, to be in jeopardy, it surely appears to me as yet that it would be an incautious and too hasty conclusion to sweep away all '*Palmellaceæ*.'"

With the exception of *Tetraspora*, *Cystococcus*, and perhaps of *Eremosphæra*, the validity, for the present at least, of the genera mentioned by Mr. Archer will hardly be disputed. It would occupy too much space to discuss further the *Palmellaceæ* and *Protococcaceæ*; and it is unnecessary to say more of the *Volvocineæ* than that the organisms composing the family are here, for the first time, classified in a systematic work on Algæ, and that they will doubtless retain their position, notwithstanding that so late as last year they were placed by MM. Le Maout and Decaisne amongst their "Algæ spuriæ"*.

The order *Zygophyceæ* is a very natural one, comprising the families *Desmidieæ* and *Zygnemeæ*. The former of these families has been made familiar to all who have paid any attention to Algæ, by Mr. Ralfs's famous work. Upwards of twenty years have passed since that work was published; and although, of course, many new species have since been described, we find little alteration of genera. *Staurocerus* is only a form of *Closterium*; *Pleurotænium* and *Triploceras* are closely allied to *Docidium*; *Geminella* is a plant of which little seems to be known. The genus was established by Turpin in 1828, in the 'Mém. du Muséum d'histoire naturelle,' vol. xvi.

The only other genus admitted by Dr. Rabenhorst, and which we do not find in Mr. Ralfs's work, is *Gonatozygon* of De Bary, which is very near to *Docidium*, and is identical with Mr. Archer's *Leptocystinema*. Ten genera are placed by Dr. Rabenhorst in the *Zygnemeæ*†. There is some confusion, as has been pointed out by

* An important paper, by M. Pringsheim, on sexual reproduction in *Pandorina* and *Eudorina* (two of the Volvocineæ) has quite recently appeared in the 'Monatsbericht' of the Berlin Academy.

† The nomenclature is not always uniform. "Zygnemeæ" (p. 101,

M. Ripart (Ann. d. Sc. Nat. 5e sér. vol. ix. p. 80), with regard to *Mougeotia*. *Mougeotia genuflexa* is figured at p. 112 in the 'Conspectus Generum,' but in the description at p. 258 it is made a synonym of *Pleurocarpus mirabilis*, Al. Br. If *Pleurocarpus mirabilis*, Al. Br., and *Mougeotia genuflexa* were really identical (which, however, is probably not the case), there could be no possible ground for the substitution of the name *Pleurocarpus* for that of *Mougeotia*, the latter having been established by Agardh in 1824, more than thirty years before the date of Braun's *Pleurocarpus*.

The remaining genera of the *Zygnemeæ* call for no special remark, except that it is very doubtful whether *Mesocarpus* is worthy of being retained, or whether it ought not to be united with *Mougeotia*.

The *Siphophyceæ* constitute a small order, divided into two families, the *Hydrogastreæ* and the *Vaucheriaceæ*. Each family is composed of only one genus. The former is represented by *Hydrogastrum*, Desv., better known under the name *Botrydium*, which name, however, is of five years' later date. The latter family is formed of the genus *Vaucheria*, which of late years has been the subject of interesting observations with regard to its method of impregnation.

Dr. Rabenhorst's fourth order, the *Nematophyceæ*, is divided by him into seven families:—1. *Ulvaceæ*; 2. *Sphæropleaceæ*; 3. *Confervaceæ*; 4. *Œdogoniaceæ*; 5. *Ulotricheæ*; 6. *Chroolepidieæ*; 7. *Chætophoreæ*. In the *Ulvaceæ* we have six genera, the first four of which, viz. *Protoderma*, *Prasiola*, *Physodictyon*, and *Schizomeris*, are very obscure, nothing whatever being known of their mode of propagation, not even zoospores having been observed. The other two genera are the well-known *Enteromorpha* and *Ulva*. It would be bold to question the validity of these long-established genera; but, unless Robin's assertions are correct (and, although made some years since, they do not appear to be confirmed), no sexual reproduction is known; and the occurrence of zoospores is a matter of little moment now that it is known that those bodies are not confined to Algæ, but that they occur also in genera of Fungi, such as *Cystopus*, *Peronospora*, and *Trichia*, and, under favourable circumstances, even in the gonidia of lichens.

The second family of the *Nematophyceæ* is the *Sphæropleaceæ*, represented by the single genus *Sphæroplea*, which possesses but one species, *Sphæroplea annulina*, a plant growing in Germany in flooded fields, and extremely interesting from the observations made a few years since by Cohn with regard to its sexual reproduction*.

The *Confervaceæ* (the third family), as limited by Dr. Rabenhorst, consists of but nine genera, the best-known of which is *Cladophora*, of which nine species are described; but the well-known variability of the plant is exemplified by the number of *divisions*, *forms*, &c. into which the genus is cut up. In the present work the three

Part III.) are called "Zygnemaceæ" at p. 110. So, afterwards, "Ulotricheæ" (p. 286) are called "Ulotrichaceæ" at p. 360; and "Chætophoreæ" (p. 287) are called "Chætophoraceæ" at p. 374.

* See Ann. d. Sc. Nat. 4e sér. vol. v. p. 187.

primary divisions are:—1, those *Cladophoræ* which are attached when young, and afterwards float freely in the form of tufts; 2, those which are always attached; and, 3, those which are at first attached, and afterwards form globular masses which are often free. This last division includes *Cladophora ægagropila.* It is doubtful whether this third division can be maintained. The eight forms of *Cladophora ægagropila* here described all grow in still water, and may possibly be only forms of *C. glomerata*, modified by their place of growth. Professor Henfrey* considered *Cladophora ægagropila* to be identical with *C. glomerata*; and Mr. Hassall, in his 'Freshwater Algæ,' took the same view with regard to *C. Brownii*, which is classified by Dr. Rabenhorst as one of the forms of *C. ægagropila.* On the other hand, Dr. Harvey states that Robert Brown (who first described it as *Conferva pulvinata*), Mr. Ralfs, and himself agreed in considering it a perfectly distinct species, at least as well characterized as any other specific form in the genus *Cladophora*, and better characterized than several reputed species†.

The fourth family, the *Œdogoniaceæ*, comprises three genera, *Œdogonium*, *Cymatonema*, and *Bulbochæte.* Much interest has attached to the former genus, on account of Pringsheim's beautiful observations upon the mode of impregnation ‡ in some of the species. Many species remain, amounting in this work to upwards of thirty, in which the antheridia and oogonia are either unknown or require further investigation, affording a fine field for the attention of algologists. With regard to *Cymatonema*, the genus seems quite unnecessary: and Dr. Rabenhorst is apparently of this opinion; for although it is figured in the 'Conspectus Generum,' the description in the text (p. 351) makes *Cymatonema* a synonym of the original name of the plant, *Œdogonium undulatum*, Bréb. Of *Bulbochæte* there are nine well-established species, besides seven others unknown to the author or of doubtful validity.

The fifth family, the *Ulotricheæ*, seems to require further consideration. It contains the genera *Hormiscia*, *Ulothrix*, *Hormidium* (which is only the terrestrial form of *Ulothrix*), and *Schizogonium.* Except for the occurrence of two kinds of zoospores (megazoospores and microzoospores, as Areschoug § has called them), *Hormiscia* might well have been placed in the *Confervaceæ.* *Ulothrix* has hitherto been considered an ally of *Draparnaldia*, and *Stigeoclonium* and *Schizogonium* might with great propriety be placed in the *Ulvaceæ.* It does not appear that the occurrence of two kinds of zoospores (one of the main features of the family) has been noticed in *Ulothrix* or in *Schizogonium.*

The *Chroolepidieæ* (fam. 6) comprise only two genera, *Chroolepus*

* Micr. Dict. p. 159.

† 'Phycologia Britannica,' remarks under plate xxx.

‡ Jahrbücher für wissenschaftliche Botanik, vol. i. p. 1.

§ Aresch. Obs. phycol. in Act. Reg. Soc. Scient. Ups. ser. 3. vol. vi. fasc. 1 (1866).

and *Bulbotrichia.* Of the latter little seems to be known; and the real nature of *Chroolepus* cannot be said to be yet ascertained. The plants composing the genus were formerly regarded, sometimes as Fungi, sometimes as Algæ; and it was thought, when Caspary discovered the zoospores of *C. aureus*, that its place was fixed with the Algæ*. After all, however, there seem to be grounds for supposing that some of the species (and if some, perhaps all) are nothing more than peculiar states of the germ-filaments of mosses.

Of the *Chætophoreæ* (Family 7), the most remarkable genera are *Chætophora*, *Draparnaldia* (*Stigeoclonium* is almost identical with it), *Coleochæte*, and *Aphanochæte*, to which latter genus Dr. Rabenhorst (in the text, p. 391) refers the very curious plant *Ochlochæte hystrix*, which was discovered by Mr. Thwaites in freshwater ditches near Bristol upon the leaves of mosses, and by the Rev. W. Smith on the stems of grasses, in brackish water, near Wareham in Dorsetshire. The plant is beautifully figured in Dr. Harvey's 'Phycologia Britannica' (pl. 226). He suggests that the freshwater and the brackish-water forms may be distinct. *Draparnaldia* is a genus which has not been allowed to pass unchallenged. Dr. Hicks, in a paper published in the 'Transactions of the Linnean Society,' and in another paper very recently read before the same Society, has suggested that *Draparnaldia* (or some of the forms of it at least) may be only states of the germ-filaments of mosses. It seems certain, however, that *Draparnaldia glomerata* produces resting spores, and this seems to point to something higher than the transitory condition of a germ-filament of a moss.

The *Melanophyceæ*, which constitute the fourth class in this work, will not detain us long; for the only freshwater plant is *Pleurocladia lacustris*, A. Braun, remarkable for its zoospores, which are produced in two different ways. The cells producing them are called *trichosporangia* and *zoosporangia*. The latter are single cells from which the zoospores are produced in a mass, by division of the cell-contents in the usual way. The *trichosporangia* are septate threads, in each cell of which a single zoospore is produced; but these zoospores, instead of escaping each from its own parent cell, make their way out through the ruptured apical cell of the trichosporangium. One other plant, the well-known *Fucus vesiculosus*, Linn., is admitted here as an Alga "aquæ submarinæ," being found in rivers as long as the water remains brackish.

We have now reached the last class (Class V.), the *Rhodophyceæ*. This is divided into five families:—1. *Porphyraceæ*; 2. *Chantransiaceæ*; 3. *Batrachospermaceæ*; 4. *Hildenbrandtiaceæ*; and 5. *Lemaneaceæ*.

The two genera in the first division (for *Porphyra* is entirely marine) are *Porphyridium*, Näg., and *Bangia*. The former is the old *Palmella cruenta* of Agardh. The two principal species of *Bangia*, viz. *B. atro-purpurea* and *B. fusco-purpurea*, are peculiar,

* Regensb. Flora, 1858. Micr. Journ. vol. viii. p. 159.

from the circumstance of their flourishing equally either in fresh or in salt water. The fructification of *Bangia* has hitherto been obscure; it has recently been investigated by Dr. Cohn in 'Schulze's Archiv,' 1867, Band iii.

In the second family, the *Chantransiaceæ*, there is but one genus, *Chantransia*. And the third family, the *Batrachospermaceæ*, contains only two, *Batrachospermum* and *Thorea*. The former genus has lately been the subject of some very interesting observations by Messrs. Bornet and Thuret* and the Comte de Solms-Laubach†. These observers have independently arrived at similar conclusions with regard to the mode of reproduction in *Batrachospermum*. The details cannot be given here, and, in fact, would be hardly intelligible without figures. The observations of Messrs. Bornet and Thuret are not confined to the genus *Batrachospermum*, but extend to a multitude of other *Florideæ*, and seem at last to have solved the problem as to the mode of sexual reproduction in that tribe of Algæ.

Hildenbrandtia is the only freshwater genus in the fourth family, the *Hildenbrandtiaceæ*. It has been the subject of some observations by Mr. Carter in Seemann's 'Journal of Botany' for 1864, p. 225.

Lemanea, Bory, a singular genus, beautifully figured by Kützing in his 'Phycologia Generalis' (pl. 19), and *Compsopogon* of Montagne, represented in Europe by a single species, *Compsopogon Corinaldii*, Ktz. (*Lemanea Corinaldii* of Meneghini), compose the fifth and last family, the *Lemaneaceæ*, with which the work closes.

It is hoped that enough has been said to give a sufficient idea of the nature of Dr. Rabenhorst's work, and to show the important assistance it will render to all who are engaged in the study of freshwater Algæ. The difficulty of making any entirely satisfactory classification of plants so little resembling one another as the different tribes of Algæ is very great. In judging of any arrangement, it will always be necessary to bear in mind that (as Messrs. Bornet and Thuret have remarked) the name "Algæ" does not represent "un ensemble nettement limité," that it is, in reality, only a common name under which are comprised families belonging to different types, and which have often no other affinities than the absence of vascular tissue and the medium in which they grow.

With these remarks, we can cordially recommend the work before us as an indispensable addition to the libraries of all algologists.

Microscopic Objects figured and described. By John H. Martin, Secretary to the Maidstone and Mid-Kent Natural-History Society. No. I. London: John Van Voorst.

We welcome with much satisfaction the appearance of this unpretending but most useful collection of drawings illustrative of the microscopic appearances presented by an extensive and well-selected

* Ann. d. Sc. Nat. sér. 5. vol. vii. p. 144.
† Bot. Zeit. May 1867, nos. 21 and 22.

series of what we may call working specimens. The design of the author has been, as he tells us, to supply a want felt by many who possess a microscope—namely, a book in which they can find accurate delineations and explanations of the objects usually contained in their cabinets, or of such as are readily procurable by a beginner in microscopic research. The explanatory text indicates in a few words the main features of the organisms depicted, as well as the points of interest they are intended to exhibit, thus enabling the student who may be desirous of examining any particular tissue or peculiarity of structure to select at once the plant or animal in which it may be most easily and satisfactorily displayed; the tyro in microscopic research will in this manner find his exploration much facilitated; and the amateur who prefers to obtain by purchase ready-mounted specimens, such as are now procurable in rich abundance, will be enabled not only to choose without any difficulty such slides as are adapted to his purpose, but (and this is by no means an unimportant consideration) to understand and explain to the uninitiated the lessons they are calculated to teach. The work, when complete, as we learn from the prospectus, will contain about 200 original figures, which, judging from those in the part before us, are well and faithfully drawn; the descriptions are concise, and the subjects sufficiently varied to constitute a very complete and comprehensive assortment, available alike for the instruction of the student of nature and for the amusement of intelligent though unscientific observers, whose curiosity, being thus excited, will doubtless prompt them to inquire more deeply concerning the functions and uses of structures so beautiful and so mysterious.

After having thus expressed our conviction of the great utility of the plan of Mr. Martin's work, and our hope that it may speedily find its way to the counter of every vendor of microscopic objects, we may be permitted to offer one or two suggestions, which will perhaps economize space in future numbers, without at all interfering with the instructive character of the descriptions, the value of which is much enhanced by their conciseness and simplicity. It appears to us to be superfluous to refer the specimens to the botanical orders to which they belong, as, for example, to tell us that the yeast-plant belongs to the Coniomycetous order of Fungi, while the maple-blight is referable to the Ascomycetous order: this kind of information is best obtained from the pages of Hooker, Smith, and Lindley; and the employment of such hard words is not inviting to the generality of readers. Another point to which we demur is the oft-repeated directions of the author that such-and-such specimens should be put up in *liquid*. We had hoped that this most unsatisfactory mode of mounting objects had become obsolete; at least, after forty years' experience, we have utterly discarded it. The most delicate specimens may be put up in the solution of gum and glycerine as readily and as permanently as in Canada balsam; they show the minutest features with the utmost clearness, and are not, like those mounted in fluid, constant sources of chagrin and disappointment.

MISCELLANEOUS.

Upon the Mode of Formation of the Egg and the Embryonic Development of the Sacculinæ. By M. E. van Beneden.

In a note inserted in the 'Comptes Rendus' of the month of February last (February 22, 1869), M. Gerbe has given the results of his researches upon the constitution and development of the ovarian egg of the *Sacculinæ*. According to this author, the ovules are formed at their first appearance of two transparent cells closely applied to each other, each provided with a vesicular nucleus and a common membrane (vitelline membrane). One of these cells increases considerably, there are developed in it a large quantity of refractive globules; whilst the other remains small and only acquires a few fine globules; and when the egg is mature, the large cell, in which the elements of the yolk are developed, has attained such a predominance that the other lobe, of which the development has remained in some sort stationary, only represents a small, scarcely perceptible eminence upon one of the poles of the ovule. M. Gerbe regards the large cell as giving origin to the vitellus, and compares it to the yolk of the egg of birds; whilst the little cell, in his opinion, represents the germ or cicatricula. Moreover M. Gerbe thinks he finds in the development of the ovum of the Sacculinæ the explanation of the physiological part performed in the egg by that body which Von Wittich, Von Siebold, and V. Carus have described in the egg of several spiders, by the side of the vesicle of Pürkinje, and which M. Balbiani has observed in certain Myriopods. One of the two cell-nuclei of the primitive bilobed ovule of the Sacculinæ would be the nucleus of the formative cell of the vitellus and the homologue of the vitelline nucleus of the egg of the spiders; the other would be the germinative nucleus or the nucleus of the germ-cell, the homologue of the germinal vesicle of the egg of the spiders and Myriopods.

The observations which I have made upon the development of the ovarian egg of the *Sacculinæ* agree, in certain points, with those of the learned embryogenist of the College of France; but the interpretation which I have given to the facts is essentially different, which is due to the circumstance that, upon some points, I am not able to confirm the investigations of M. Gerbe, and that some important facts have escaped his attention.

The ovules are not, at their first appearance, formed of two cells closely applied to each other; they consist, at first, of a single cell, formed of a perfectly transparent viscous matter (protoplasm) holding in suspension some globules which strongly refract the light, and of a vesicular nucleus, with very delicate outlines, measuring about half the diameter of the cell and provided with a single very refractive nucleolus. The diameter of this cell is about 0·06 millim. Along with these cells are seen others, which present an elongated form and are provided with two nuclei, without, however, manifesting any tendency to the division of their bodies. Others, on the contrary, present at one of their poles a little bud, the size of which increases until it becomes equal to that of the maternal cell; one of the nuclei passes to the interior of the bud, and thenceforward we may recognize two cells, separated from each other by a circular constriction, which deepens gradually; the two daughter cells become individualized, but remain closely connected with each other. The two cells, therefore, are produced by division from a primitive mother cell. I have always found it impossible to distinguish any trace of cell-membrane about these young ovules.

It is indispensable here to make two observations:—first, that these mother cells occur in great quantity in the ovaries immediately after oviposition, as may be seen from the fact that the ovisacs contain eggs which are still at the first commencement of embryonic development; secondly, that the dimensions of the mother cells are the same as those of the little cells which are found in the form of an eminence situated at one of the poles of the mature egg. All the other characters of the mother cells are identical with those which are presented by these polar cells of the mature eggs. In both we see a perfectly transparent protoplasmic body, holding in suspension some rounded, very refractive globules, and we even find some of considerable size, which present no difference in character from those of the vitellus. We distinguish in them a vesicular nucleus, with very delicate outlines, provided with a nucleolus endowed with considerable refractive power.

The mother cells of which I have spoken give origin, by means of division, to two daughter cells. At the commencement of their development these cells are all exactly alike. Soon, however, their bulk increases slightly, and each of them acquires by degrees the dimensions of the mother cell. They each contain some refractive globules; but soon the number of these globules increases greatly in one of the two united cells, and, at the same time, its size begins to exceed that of its congener. From this moment it becomes impossible to distinguish, in the midst of these refractive globules, the nucleus of the enlarged cell. I have never afterwards succeeded in distinguishing in the mature egg the cell-nucleus in the midst of the vitelline mass. The cell increases more and more; it completely fills itself with refractive globules, of which the size increases as quickly as the number. Whilst enlarging, this cell (which we may now call the *egg*, since we recognize distinctly in its contents the characters of a true vitellus) preserves a perfectly regular spheroidal form; only at one of its poles the second cell, which has remained stationary in its development, is attached. When the egg has attained a diameter of from 0·16–0·18 millim. we distinctly recognize in it a cell-membrane, which is developed at the expense of the periphery of the protoplasm of the ovicell, and betrays itself by its dark outline. This membrane (vitelline membrane) is not a common envelope of the enlarged cell (which is the egg in course of development) and of the transparent cell joined to one of its poles; it does not enclose this latter cell, but, on the contrary, its contour stops at the margin of the surface of attachment of the egg and the polar cell. When the egg has arrived at maturity, it presents a regular ellipsoidal form, and at one of its poles the polar cell is always found, retaining its hemispherical form and its original transparency and dimensions. This cell is outside the vitelline membrane, of which we can follow the perfectly regular dark outline between the vitellus and the polar cell on a level with the surface of attachment; the vitelline membrane, however, is slightly depressed, and perhaps it is wanting, at the centre of this surface.

Along with these mature eggs which bear near their poles a transparent cell, are others in which it is not possible to distinguish any polar cell, but which still present, at one part of their surface, a depression corresponding to the old surface of attachment; the extruded eggs never show the least trace of the polar cell, or anything which resembles a cicatricula. Considering this fact in conjunction with that of the existence in the ovary, a little time after oviposition, of isolated cells, which I have called *mother cells*, and which present all the characters of the polar cells of the mature eggs, we see that *the polar cells of the mature eggs are not a constituent part of the egg, comparable to the cicatricula of the egg of birds; these cells separate from the surface of the mature eggs, remain in the interior of the ovary, and increase in number by division to give birth to two daughter cells, which remain attached to each other, and of which one produces in its turn an egg.* The body which M. Gerbe has regarded as representing a vitelline cell, destined to form the nutritive elements of the vitellus, is in reality the entire egg; its nucleus represents the germinal vesicle; and its contents consist of a homogeneous protoplasmic liquid, holding in suspension some refractive globules (nutritive elements of the vitellus).

These observations suffice, it appears to me, to justify the conclusion that I draw from them; but I find in the analogies which the development of the eggs of the *Sacculinæ* present to those of a great number of other Crustacea, and in the development of the embryo of the *Sacculinæ*, the complete demonstration of the conclusion which has just been formulated.

In a great number of parasitic Copepoda (*Caligus*, *Clavella*, *Lernanthropus*, *Congericola*) the ovary presents the form of an oval sac (*germigene*), of which the anterior extremity is prolonged into a tube (*vitellogene*); the latter gradually widens and opens exteriorly, after having formed in the interior of the body a certain number of convolutions. The germigene is filled by a very slender transparent band, twisted and coiled upon itself, which at the entrance of the gland is produced into the tube which represents the vitellogene. This cord is really formed of an immense number of small perfectly transparent protoplasmic cells provided with a very small nucleus. They are flattened, and resemble little disks piled together. In the vitellogene each of these little cells increases in size, and becomes filled with refractive elements, to become an egg, at the same time that their nucleus becomes the germinal vesicle. The eggs retain this flattened discoidal form, and they are accumulated in the vitellogene like coins. In some other Lernæidæ (*Anchorella*, *Lerneopoda*) the division of the ovary into germigene and vitellogene does not exist; but this organ is formed of a ramified tube, of which all the branches are filled with fragments of protoplasmic cords, the characters of which are identical with those of the protoplasmic cords of *Clavella* and *Congericola*. *If the walls of the ovary are torn, a great number of eggs are set at liberty, each of which bears at one of its poles a fragment of protoplasmic cord formed of piled-up discoidal cells.* When the eggs have arrived at maturity they separate from the cord, are ejected, and it is the cell of the protoplasmic cord which was immediately adjacent to the egg that increases, becomes filled with refractive elements, and becomes in its turn an egg. It is impossible not to recognize that these eggs, bearing at one of their poles a fragment of ovarian cord, are really the analogues of the eggs of the *Sacculinæ* provided with a polar cell. The polar cell represents anatomically and physiologically the fragment of the protoplasmic cord of *Anchorella* and *Lerneopoda*, which separates, like it, from the mature egg to furnish new eggs.

In studying the first phases of the embryonic development of the Sacculinæ, *I have ascertained that these animals present at first the complete segmentation of the vitellus.* Now, as I have shown in a previous memoir, the complete segmentation of the vitellus only takes place when the whole mass of the nutritive elements occurs in suspension in the protoplasm of the ovicell, which excludes the idea of a cicatricula. A cicatricula exists when a great part of the nutritive elements is outside the protoplasm of the ovicell, as in birds. In this case these elements do not take part in the division of the ovicell, and the segmentation is partial; it occurs at the expense of the cicatricula exclusively. But in the *Sacculinæ* the whole mass of the vitellus becomes divided into two equal portions, in consequence of the formation, all round the small section of the egg, of a furrow which starts from the periphery and advances gradually towards the centre. Soon afterwards a new furrow appears on the surface of the vitellus, crossing at a right angle that which had first appeared. The mass of the vitellus is thenceforward divided into four portions; they have each the form of a quarter of an ellipsoid which has been divided by two perpendicular planes both passing through the centre. From this moment in each of the four segments a separation takes place between the protoplasmic element and the nutritive elements of the vitellus. The protoplasm of the four segments, carrying with it their nuclei, moves to one of the poles of the egg, which is the extremity of the diameter in which the two planes intersect. We see the four segments become more and more clear at this point, and free themselves completely from the nutritive elements, which are driven to the opposite poles. Then the clear parts, each provided with a nucleus, are separated by a furrow from the darker portion of the segment; they constitute the four first embryonic cells, in the form of little protoplasmic globes, each provided with a nucleus. The four large dark spheres, formed of very refractive elements, no longer represent cells; they will also become fused together, so as to form a single mass of nutritive elements. The embryonic cells, on the contrary, multiply by division, to form a cellular zone of increasing extent, which finally, under the form of a cellular vesicle, will enclose the central mass of nutritive matter. From that time the blastoderm is formed.

It results from this that the large cell, which M. Gerbe has regarded as representing the body producing the vitellus, is really the entire egg,—that the egg of the *Sacculinæ* cannot be compared to the egg of birds, since it is impossible to distinguish in it any parts corresponding to the yolk and the cicatricula,—that the polar cell, which has been considered to represent the germ, is analogous to the protoplasmic cord of the egg of the *Anchorellæ*,—and that this cell separates from the mature egg, and remains in the ovary to become divided there and give origin to new eggs.

It is very evident, also, that no comparison can be established between the vitelline body of the eggs of some spiders, or of certain Myriopods, and the cell-nuclei of the double egg of the *Sacculinæ*. The vitelline body of the egg of the spiders, of which MM. von Wittich, von Siebold, and V. Carus have studied the constitution and the mode of formation, and of which M. Balbiani has proved the existence in the Myriopods, never presents the characters of a vesicle or of a cell-nucleus. This body, far from being general in all the animal series, does not exist in all the Araneida, nor even constantly in the same species of Myriopod, such as *Geophilus simplex*: the signification of this accidental element of the egg remains still to be determined.—*Comptes Rendus*, tome lxix. November 29, 1869, pp. 1146–1151.

Food of Oceanic Animals.

Dr. Wallich complains that I omitted to notice what he had published on the subject. I must confess that I overlooked it.

In his 'North-Atlantic Sea-bed' (p. 131), he says that it may be asked "under what other conditions than exceptional ones can marine animal life be maintained without the previous manifestation of vegetable life, as must be the case if it exists at extreme depths?" and he answers this inquiry by submitting that "in the majority of the marine Protozoa, as, for instance, in the Foraminifera, Polycystina, Acanthometræ, Thalassicollidæ, and Spongidæ, the proof of these organisms being endowed with a power to convert inorganic elements for their own nutrition rests on the undisputed power which they possess of separating carbonate of lime or silica from waters holding these substances in solution." But surely this is not a satisfactory answer to the inquiry. A limpet separates carbonate of lime from sea-water; but it cannot be assumed that this animal (which is well known to be a vegetable-eater) has also the power of converting other inorganic substances for its own nutrition. Foraminifera, as well as Amœbæ, are usually considered animal-eaters, feeding by means of their pseudopodia or expansions of the sarcode. As regards sponges, we find, from Dr. Bowerbank's Monograph (vol. i. p. 122), that, in the greater number, their nutriment "is probably molecules of both animal and vegetable bodies, either living or derived from decomposition," and that "the fæcal matters discharged by the oscula exhibit all the characteristics of having undergone a complete digestion."

If it be any satisfaction to Dr. Wallich, I assure him that my estimate of his memoir on the North-Atlantic Sea-bed remains unchanged. It is only to be regretted that the work is incomplete.

J. GWYN JEFFREYS.

22 January, 1870.

Note on the Habits of the Discophora. By the Rev. THOMAS HINCKS, B.A.

In the Number of the 'Annals' for October last, Dr. Gray reports an interesting observation on the habits of certain Medusæ, which had been communicated to him by Mr. M'Andrew. This gentleman had informed him that he had often seen the sea-jellies (*Medusa æquorea*, Forskål) "lying on their backs at the bottom of the beautiful clear water of the Red Sea, with the tentacles expanded like a flower." Dr. Gray adds that he is not aware that this habit has been observed or recorded before.

My object in writing is to point out that the same thing was noticed long ago by Mertens. He states (as quoted by Agassiz) that he had constantly found Medusæ (*Polyclonia Mertensii*) in the lagoons of Ualan, "with their arms spread and turned upward, resting upon the ground." As Agassiz adds that he himself had always seen the members of this genus "in the reverse position, the arms downward," Mr. M'Andrew's testimony in support of the elder naturalist has a positive value. Probably when at rest the free zooids of the *Discophora* generally may assume the position described by Mertens, or at any rate those which are accustomed to seek their food at the bottom of the sea.

Agassiz has studied another species (*Polyclonia frondosa*) on the Florida reefs, and states that it has the curious habit "of groping in the coral mud at the bottom of the water, where thousands upon thousands may be seen crowded together, almost as closely as they can be packed upon the bottom, at a depth of from six to ten feet. When disturbed, they do not rise, but crawl about like creeping animals, now and then only flapping their umbrella."

Note on the Occurrence of two Species of Crustacea not hitherto observed in Scotland. By M. WATSON, M.D.

When dredging, in the month of September, last year, along with some friends, off the north coast of the island of Mull, I had the good fortune to procure two species of Crustacea which, so far as I can ascertain, have not before been obtained on any part of the Scottish coast, although they would appear to be not uncommon on some parts of that of England. These are the angular crab (*Gonoplax angulata*) and the four-horned pea-crab (*Pisa tetraodon*) of Bell.

The former was taken in Bloody Bay, at a depth of about twenty-five fathoms, in soft mud, along with a quantity of *Virgularia* and *Pennatula*. It proved, on examination, to be a young male, seemingly half-grown, as the claws had not as yet attained the size characteristic of the adult. The nature of the ground from which the specimen was taken would seem to corroborate the statement of Cranch, as quoted by Bell, "that they live in the hardened mud, and that their habitations, at the extremities of which they live, are open at both ends." The second species above mentioned was taken off the lighthouse situated on the north coast of Mull, on stony ground, at a depth of about fifteen fathoms, and seemed, from its small size, to be also an immature specimen.

A third species was also obtained, which, though by no means so uncommon as the two preceding, seems worthy of mention. This is the spinous shrimp (*Crangon spinosus*, Bell), a specimen of which was taken at the entrance to Loch Sunart, at a depth of twelve or fourteen fathoms, and proved to be an adult of large size.

No other specimens of either of these species were obtained, although the various localities were carefully dredged on several occasions during a month's residence in that quarter; so that the different species would seem to be by no means abundant in that neighbourhood.

As previously remarked, the two first-mentioned species do not seem to have been before observed on the Scottish coast, while the latter seems only to have been taken in Shetland. I have therefore thought that it might be of interest to mention their occurrence on the west coast, more especially at a time when so much attention is being directed to the elucidation of the laws governing the distribution of different species of marine animals.

Spatangus meridionalis, Risso.

My friend Dr. Mörch of Copenhagen, who is now at Nice for his health, has just given me some information which may serve to decide the question whether the above-named species is the *Spatangus Raschi* of Lovén or merely the *S. purpureus* of Müller. Dr. Mörch says that at my request he has examined Risso's collection, that he found among the unpublished drawings of that author a figure of *S. meridionalis* very like *S. purpureus*, and that in the collection were several specimens of the latter species with a label on which was written "Mon Spatangus meridionalis est le Sp. purpureus, Lam."

J. Gwyn Jeffreys.

Note on the Arrangement of the Pores or Afferent Orifices in Cliona celata, *Grant*. By M. Léon Vaillant.

In the month of October last I had the opportunity, thanks to the kindness of M. Lemaitre, of Cancale, of witnessing the dredging of the oyster-beds for the annual inspection. This circumstance enabled me to observe in the living state that singular sponge which perforates the shells of certain Mollusca, the *Cliona* *celata*, which, since the time of Grant, has so often attracted the attention of naturalists. In studying these creatures, immersed in the water immediately after they were taken from the dredge, so as to approach as nearly as possible to the conditions of natural life, it appeared to me that we had hitherto described and interpreted in an incomplete manner the nature of the prolongations or papillæ which the *Clionæ* emit through the perforations of the oyster-shells, and the very perceptible although not very rapid movements of which have struck all those who have been able to examine these animals.

The prolongations are of two sorts. Some (the only ones well seen by previous authors) are hemispherical, more rarely cylindrical, and perforated at their summit; at this point there is, in fact, a wide opening, which may attain as much as 1 millim. in diameter: it is the orifice of a canal traversing the whole papilla and communicating with the ducts which in this as in all the other sponges traverse the parenchyma in all directions. The prolongations of the second kind, which are much more numerous than the preceding, have an entirely different form, which may be compared to that of the rose of a watering-pot; they are in the shape of a reversed truncated cone, so that on leaving the perforation they enlarge gradually, and terminate in a very elliptical convex surface; this is not widely perforated, but presents an elegant network of fibres anastomosing in all directions, which are formed of bundles of spicula covered with sarcode. The fine meshes of this net form so many apertures which open by short conduits into a central canal, situated, as in the prolongations previously described, in the centre of the papilla, and terminating in the same way in the general system of internal irrigation.

These second prolongations of the *Clionæ* were certainly seen by Grant; but he described them as being the transitory state of the papilla just before its opening widely. From my observations, repeated and followed up long enough to allow me to present them with confidence, this is not the case: the surface of the perforated shell always presents side by side with papillæ of the first kind others constructed upon the second type; and in individuals which I have preserved living and active for nearly twenty days, I was even able to demonstrate that, after taking them from the water (which is a certain means of causing the prolongations to be retracted), on replacing them in the aquaria after some time, the same perforations always give passage to papillæ of the same kind. We might imagine, considering the simplicity of the structure of these creatures, that in certain cases changes might take place; but I have not observed any.

We may conclude, from this arrangement, that, in *Cliona celata*, whilst the papillæ with wide perforations are, as has long been ascertained, the oscula or efferent orifices of the current of water which continually traverses the parenchyma of the sponge, the papillæ of the second kind bear, collected upon their widened surface, the afferent orifices or pores. It is to be remarked that hitherto, whilst indicating the efferent apertures, no one appears to have thought of seeking the orifices of entrance, which, however, could not occur, as usual in the other sponges, upon the general external surface, as this, being immediately applied against the walls of the cavities which the *Cliona* inhabits, is not in contact with the ambient fluid. If this exceptional arrangement of the pores exists likewise, as is probable, in the allied species, we may find in it an anatomical character for this genus, which has hitherto been founded exclusively upon the biological fact of its boring-faculty.—*Comptes Rendus*, January 3, 1870, tome lxx. pp. 41–43.

British Killer or Orca. By Dr. J. E. Gray, F.R.S. &c.

The examination of the skulls in the British Museum shows that two species of *Orca* or Killer inhabit the English coast.

1. The smaller has a broad beak, of nearly equal width for the greater part of its length. This is the skull figured by Cuvier in his work on fossil bones; and his figure has been copied by many authors. I propose to call this species *Orca latirostris*.

2. Judging from the size of the skull and the length of the skeleton in the British Museum, the other species must be considerably larger. The beak of the skull is elongated, and tapers nearly from the orbit to the front end, which is narrow and acute. I have distinguished this species as *Orca stenorhynchus*.

On the Antiquity of the Ass and Horse as Domestic Animals in Egypt. By M. F. Lenormant.

The author remarks upon a statement of Professor Owen's, that neither the horse nor the ass was known in ancient Egypt—that is to say, up to the sixth dynasty, about 4000 years B.C. He says that the horse undoubtedly does not appear upon any monument of the ancient empire, or of the middle empire, including the twelfth and thirteenth dynasties. But when the monuments recommence under the eighteenth dynasty, about 1800 years B.C., the horse appears as an animal of habitual use in Egypt.

The ass, on the other hand, appears upon the oldest Egyptian monuments. It is frequent in the tombs of the ancient empire at Gizeh, Sakkarah, and Abousir. As early as the fourth dynasty, asses were as numerous in Egypt as they are at present: the tomb of Schafra-Ankh at Gizeh represents its occupant as the possessor of 760 asses; and those of other tombs boast of being the owners of thousands of asses.

The author remarks further that, considering the intimate relations existing between Egypt, Arabia Petræa, and Southern Palestine during the ancient empire, we may infer the absence of the horse in the latter countries at this period; and in support of this view he cites a painting from the tomb of Noumhotep at Beni-Hassan-el-Kadim, and also the evidence to be derived from the Book of Genesis, in which the horse is first mentioned in connexion with the establishment in Egypt of the family of Jacob, in the time of the later Shepherd Kings. This mention of the horse nearly coincides, in point of time, with the most ancient notice of that animal on Egyptian monuments. The author thinks it possible that the introduction of the horse into Syria and Egypt was effected by the invaders from whom the Shepherd Kings were derived.—*Comptes Rendus*, tome lxix. December 13, 1869, pp. 1256–1258.

Embryonic Development of Bothriocephalus proboscideus. By E. Mecznikow.

M. Kölliker has already remarked that in *Bothriocephalus proboscideus* only a part of the contents of the ovum is employed in the formation of the embryo, and that the rest forms a layer of peripheral cells, the fate of which remained unknown to him. M. Knoch disputed the accuracy of this observation, but wrongly, as it now appears. M. Mecznikow describes the ova of this Cestoid worm as filled by an ovarian cell surrounded by a mass of granular vitellus. The cell undergoes total segmentation, whilst the vitelline mass takes no part in the formation of the embryo. From the cellular aggregation produced by segmentation, two cells, furnished with larger nuclei than the others, are soon seen to separate; they fix themselves at the two poles of the ovum, and only disappear at the close of the embryonic life. M. Mecznikow has seen a perfectly similar arrangement in the ova of *Tænia cucumerina*.

After the segmentation, the mass of embryonal cells acquires a rounded form, and the embryo divides into a central nucleus and a peripheral layer, the latter formed of very distinct cells. Whilst the nucleus forms the true larva of the Cestoid worm, with its hooklets, the layer of peripheral cells becomes converted into a delicate membrane, which finally loses its cellular structure and acquires the appearance of a homogeneous cuticular envelope.

Although this envelope of the embryo never becomes covered with vibratile cilia, M. Mecznikow does not hesitate to compare it to the ciliated envelope of *Bothriocephalus latus*. In fact, the embryonic development of *B. proboscideus* shows that the embryonal envelope is the homologue of the amnios of the embryos of Insects and other Arthropoda. In this case the ciliated envelope of the larva of *B. latus* would be a sort of amnios persisting for a long time after hatching. But then we must extend this homology to the ciliated embryos of the Monostoma and of M. Desor's Nemertean. To be consistent, we must even regard *Pilidium* as a sort of temporary envelope of its *Nemertes*, as an amnios which has attained a remarkable degree of independence.—*Mélanges Biologiques tirés du Bulletin de l'Acad. Imp. de St. Pétersb.* tome vi. p. 717; *Bibl. Univ.* January 15, 1870, *Bull. Sci.* p. 87.

Note on a Station of a living Encrinus (Pentacrinus europæus) *upon the Coasts of France.* By M. Lacaze-Duthiers.

Since the investigations of Messrs. W. Thomson and Carpenter, it is well known that the form of the *Comatulæ* in the embryonic state is precisely that which has been regarded by naturalists, especially palæontologists, as characteristic of one of the most remarkable groups of the Echinodermata, that of the Crinoids or Encrinites.

This discovery is of the highest importance, as well in a purely zoological point of view as in zoological philosophy; for it shows once more how much better the affinities of animals will be defined when zoologists shall have taken comparative evolution and morphology as their guides.

The opinions of the English naturalists upon the relations of the *Pentacrini* and *Comatulæ* have been too well demonstrated by them for it to be necessary to adduce new proofs in its support; therefore my desire is simply to make known a station, easy of access, where it is possible for any naturalists who may desire it to repeat one of the most remarkable observations in embryogeny and experimental zoology.

The port of Roscoff, situated at the northern extremity of a broad tongue of land which projects northwards into the English Channel, between Morlaix and Saint-Pol-de-Léon on the east and the bay of Pouldu on the west, is surrounded by innumerable reefs, which become dry at low water, and permit the zoologist to make the most varied collections there; moreover the Gulf-stream, by bathing this coast, maintains in these parts a temperature eminently propitious to the development of animals. Lastly, to the north, a long granite band, running east and west (the isle of Bass), forms a breakwater against the waves of the high sea, and protects the channel which lies between it and Roscoff. In consequence of these conditions, the fauna is particularly rich at this part of the coast.

For two years in succession (in 1868 and 1869) I have passed a part of the summer in making researches in this locality, one of the richest on our coasts. I shall return there again; for it is my intention to make it known and to take it as the type of the marine fauna of the coasts of France, for which I have already collected abundant and valuable materials.

On descending from the churchyard of Roscoff, at low water, upon the beach, by going directly north, we see before us some large granite masses which, never being covered, form islets even at the highest tides. These are:—to the east and to the right of the observer, the two Bourguignons; to the left, or to the west, the isle Verte; and further towards the east, some rocks which become covered and uncovered, amongst which I may cite Meinanet and Rolas. Among all these reefs and in the channel the sea on retiring leaves broad and fine meadows of *Zosteræ* and sandy flats covered with stones, both inhabited by numerous species of animals; by an excessive variety of simple and compound Ascidia, Bryozoa, Sertularia, Sponges (especially calcareous), Echinodermata, *Synaptæ*, *Lucernariæ*, *Caryophylliæ*, numerous *Actiniæ*, *Planariæ*, *Borlasiæ*, naked and other Mollusca in great abundance, &c. &c., which well compensate the zoologist for the trouble of examining these shores.

The two zones which the seaweeds habitually occupy, the one at the highest (*Fucus vesiculosus, F. serratus*), the other at the lowest (*Laminaria*) water, are clearly separated at Roscoff by *Himanthalia lorea*, which is employed in the country as manure, under the name of *filet*, in the culture of vegetables. The zone of the filets is uncovered at the period of the syzygies; but it is not entirely dry, except at the greatest tides, when the *Laminariæ* situated below it are likewise accessible. All these particulars are necessary; for it is impossible to form an idea of the difficulty of investigations among the rocks covered with *filets*, unless one has been in the midst of the long bundles of viscous lashes of the *Himanthalia* which conceal the ruggedness of the stones and slip away under the feet. Nothing is to be found among them; and their examination is not only excessively difficult, but actually dangerous, from the continual falls that one gets.

In the Laminarian zone, investigation is at the same time easier and more fruitful; but what is of importance in the very peculiar point of view now before us is the presence of *Sargassum* in this zone, and the curious fact that this seaweed sometimes abandons the deeps to ascend even to a considerable elevation, under circumstances which it is important to indicate.

At the time of the lowest tides, the sea, in retiring, hollows out furrows in the sandy flats and in the marine meadows. The water which flows from the parts which have emerged forms in these furrows true rivulets, often of considerable size and rapidity. At the west of the isle Verte, and of the Bourguignons, these erosions are numerous; and it is in the water which fills them that we see the *Sargassum* rise high up, and that we find abundance of *Pentacrinus europæus*. If at the time of the spring tides we go to these streams and detach large and tufted stalks of *Sargassum*, tearing them up quite close to the bottom, and selecting the most branchy, we are nearly sure, in the months of July and August, and the beginning of September, to meet with Pentacrini.

This search must be made as follows:—When plants of *Sargassum* are very much branched, the branchlets interlace and form a sort of bush, in the midst of which *Antedon rosaceus* particularly likes to introduce itself and reside. It must be added that the Ascidia, the Sponges, the Sertularia, and the Bryozoa are also so numerous there, that each plant of *Sargassum* would furnish a collection of itself. The *Antedon* is there sometimes in such abundance, that it colours the stems, by twisting its arms around them; and as it occurs there of all sizes, I thought the station a proper one for its development, and set to work to find its *Pentacrinus*. My expectations were soon realized, and I was able to collect, even on the beach, very fine examples. But it is more convenient to carry away stalks of *Sargassum* covered with *Antedon*, and to examine them by separating the small branches under the lens and in water. I have thus found *Pentacrini* of all ages. I have preserved them living for a long time; and those of the largest size, after having moved about and acquired the very elegant forms which have obtained them their name, have been metamorphosed under my eyes. They quitted their peduncle, characteristic of the crinoid form, to become free and mix with the adult *Antedons*, in the midst of which it was impossible to recognize them.

I believe, therefore, that, by following the preceding indications, all zoologists will be able to verify the observations of Messrs. W. Thomson and Carpenter. This has already been done by MM. Lemire and Myèvre, who, after having worked a long time under my directions in my laboratory, at the museum of the Sorbonne, went, by my advice, to Roscoff.

M. Lemire, having quitted Roscoff only after the high tide at the beginning of October, could no longer find any *Pentacrini* at this period; even in September their number appeared to me to have diminished visibly, but we still found many *Antedons*. M. E. Grube, of Breslau, who joined us at the beginning of September, can confirm this.

Hence we may suppose that it is chiefly in the warm season that we may be certain of finding living Encrinites in the place which I have indicated and of repeating the observations of the English authors.

A last remark will explain the care here taken to indicate this station. In excursions in the environs of Roscoff—for example, to Kainon, a plateau of rocks situated to the south-east of Sainte Barbe, in the river of Saint-Pol-de-Léon, which is only uncovered at the greatest tides, to the north of *Thirzaouson*, to the west of the Fort of *Perharidi* and of the *Roche du Loup*, I have never found the *Pentacrinus*; and yet the *Sargassum* abounded in nearly all these places. The conditions combined in the sheltered rivulets behind the isle Verte are, therefore, doubtless those most favourable for oviposition and the development of the embryo.

It seemed to me useful to call the attention of naturalists to a locality where we are able to repeat an observation of this importance so easily; moreover the *Pentacrinus europæus*, placed by the side of its *Antedon rosaceus*, is rare in museums, because naturalists, especially French naturalists, who have collected it, are, I believe, few in number; and I do not know that it has yet been indicated upon our coasts.—*Comptes Rendus*, tome lxix. December 13, 1869, pp. 1253–1256.

Observations on the Salivary Glands in Myrmecophaga tamandua. By M. J. Chatin.

The author has discovered in this mammal a third pair of submaxillary glands, having, like the others, proper excretory ducts.—*Comptes Rendus*, November 15, 1869, tome lxix. p. 1017.

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XVI.—*On the Myology of the Wombat* (Phascolomys wombata) *and the Tasmanian Devil* (Sarcophilus ursinus). By ALEXANDER MACALISTER, Professor of Zoology and Director of the Museum, University of Dublin *.

THROUGH the kindness of Professor Haughton, I have recently had the opportunity of making, with his assistance, a careful dissection of the two above-named marsupials. They were both salted specimens, but in excellent preservation. The Wombat was 33 inches long, and was an adult female full-grown; it had a young one in its pouch surrounded by shreds of a membrane, but of what nature could not be ascertained. The embryo was 1 inch and 2 lines in length.

The Tasmanian Devil was about 27 inches long and in good condition; it was also a female, but not fully grown, the hinder molar teeth were not cut. The muscles of the wombat were firm and red; those of the native Devil were softer and paler, but still distinct. The dense pig-like skin of the Wombat was with difficulty taken off, as the subjacent tissue was dense and firm. The platysma and panniculus carnosus in both are weak and undefined.

The trapezius of the Wombat arises from the occipital ridge, from the cervical spines and ligamentum nuchæ, and from the seven upper dorsal spines; it stretches as an undivided muscular sheet to the spine of the scapula and the acromion process. The anterior fibres were not attached to the clavicle, but, gliding over it, replaced the clavicular deltoid, and were inserted into the deltoid crest of the humerus, overlying the great pectoral. There was no tendinous intersection over the line of the clavicle, although such a line often exists when

* Communicated by the Author, having been read before the Royal Zoological Society of Ireland.

this muscle misses the clavicle—for instance, in *Manis Dalmannii*, in which the arrangement is similar, but the muscle is crossed by an inscription at the line of the clavicle (Humphry); this is interesting, as *Manis* is a fossorial animal like the Wombat. In the Civet (*Viverra civetta*) this same arrangement exists, and an inscription is present (Devis); and in the Agouti and Guinea-pig, Dog, Dingo, Badger, Lion, and many other animals a tendinous line marks the junction. In the Rhinoceros there is no tendinous inscription, nor in the Llama. Prof. Owen describes the anterior fibres of this muscle in *Perameles* as continued into the pectoralis major, which I suppose is a similar arrangement. The trapezius in *Sarcophilus* arises from the occipital crest and nuchal ligament and from the upper nine or ten dorsal vertebræ; it is inserted into the scapular spine, the upper border of the acromion, and to the outer fourth of the clavicle. The part of the muscle corresponding to the root of the spine of the scapula was weak and tendinous, and nearly divided the fleshy part into an upper and lower trapezius; however, a thin muscular margin near the spines of the vertebræ saved it from this division. In *Macropus giganteus* it arises from the ligamentum nuchæ and from the three lower cervical and six upper dorsal spines. It is situated similarly in Bennett's Kangaroo. In the Opossum and Phalanger its occipital origin is much larger, and it extends downwards along all the dorsal spines. The insertion in all is constant into the outer half of the clavicle, the acromion process, and the whole spine of the scapula; and in the Opossum it is attached to the upper part of the vertebral edge of the scapula, as well as to the spine.

Beneath the trapezius, the omo-atlantic stretches, in the Wombat, from the atlas and axis to the outer half of the scapular spine, and into the upper margin of the acromion process. In *Sarcophilus* its attachments were from the transverse process of the atlas and to the outer half of the spine of the scapula, and into the upper edge of the acromion process. In the Wallaby it arises from the three upper cervical vertebræ, and is inserted into the anterior fourth of the scapular spine and into the whole length of the clavicle. In the Giant Kangaroo it is attached to the transverse process of the atlas and axis, and is inserted as in the Wallaby. In the Opossum it arises from the atlas alone, and is inserted into the anterior fifth of the spine of the scapula. (For an account of the synonyms of this muscle, see the anatomy of *Bradypus tridactylus*, Ann. Nat. Hist. 1869, vol. iv. p. 52.)

The rhomboideus is composed of three parts, but they are not separable in the Wombat; it arises from the upper four or five dorsal spines, from all the cervical, and from the occipital bone below the last; it is inserted into the entire length of the vertebral margin of the scapula. In *Sarcophilus* its attachments are similar, but it is distinctly divisible into a rhomboideus occipitalis (Murie and Mivart, occipito-scapularis of Wood) and a proper rhomboid made up of the fused major and minor. In both it is a thick muscle. It is faintly divisible in the Opossum (Meckel says, not) and Phalanger as in the native Devil, but less in the *Macropus giganteus* and Bennett's Kangaroo: in these the muscle only extends to the three upper dorsal spines; in the Opossum and Phalanger, on the other hand, it extends down to the fifth and sixth dorsal spines.

Serratus posticus, in the Wombat, is a large muscle arising tendinous from the whole series of dorsal spines except the last, and is inserted fleshy into all the ribs, forming a continuous sheet, as in the Pig. In *Sarcophilus* the serratus passes from the upper half of the dorsal spines, and is inserted into the upper eight ribs.

Serratus magnus, in the Wombat, is divided into two parts, the upper of which includes the levator scapulæ; this portion is very weak, and its attachments are, as usual, from the lower four cervical vertebræ and from the upper three ribs to the upper part of the scapular spine. The lower part arises from all the ribs from the fifth to the eleventh inclusive (there are fifteen ribs, as described by Waterhouse, 'Marsupialia,' p. 280), and is inserted into the inferior angle of the scapula, at the subscapular side, and into a small part of the axillary margin. In *Sarcophilus* its attachments are similar, and the levator scapulæ is inseparable. In *Macropus giganteus* and the Wallaby it arises from the transverse processes and ribs from the third cervical to the sixth dorsal vertebræ continuously. In the Opossum the levator scapulæ arises from the transverse processes of all the cervical vertebræ but the atlas, and is nearly inseparable from the serratus proper, which extends from the first to the eighth ribs (Meckel describes them as separate); and the muscles are similarly arranged in *Phalangista*.

The splenius in the Wombat is a continuous sheet, and not easily divided into the two parts, capitis and colli; it arises from the spines of the vertebræ forming the upper fifth of the dorsal region and from all those of the cervical vertebræ below the axis; the fibres are inserted into the occipital bone and into the posterior aspect of the upper cervical transverse processes. In *Sarcophilus* the splenius passes from the four upper dorsal and six lower cervical spines to the transverse process of the atlas and the occipital bone.

The complexus is very large in the Wombat, and is attached to the transverse processes of all the cervical vertebræ and the upper five dorsal vertebræ; its insertion is into the occipital bone, as usual, on each side of the mesial line. In *Sarcophilus* it is very large, and is intersected by several inscriptions. In the *Macropus giganteus*, the Phalanger, and Opossum, as well as in the Wallaby, it is similar in arrangement.

The semispinalis colli, the ilio-costalis dorsalis, and colli, the recti capitis postici major and minor, the obliqui capitis, are all normal in all, the first three merely varying slightly in the number of their vertebral attachments. The intercostals, the levatores costarum, interspinales, intertransversales, longissimus dorsi, and trachelo-mastoid are all normal, and in none of the marsupials presented any features of interest.

The latissimus dorsi of the Wombat arises from the lower six ribs, from the spinous processes of the lower eleven dorsal vertebræ, and from the lumbar aponeurosis. It has no connexion with the angle of the scapula, and is inserted in front of the teres major, and slightly connected with it, into the usual situation on the humerus. This muscle sends off the dorsi epitrochlear muscle, or omo-anconeus of Prof. Owen, which, arising directly from the tendon of the latissimus dorsi, is inserted into the inner side of the olecranon process. In *Perameles*, Professor Owen describes this muscle as having an accessory origin from the inferior angle of the scapula. In *Sarcophilus* its attachments are the same, and the dorsi epitrochlear muscle is as in the Wombat. In the Opossum it arises from the seventh to the thirteenth dorsal vertebræ, and from the lumbar vertebræ, by a fascia, and, as remarked by Meckel, from none of the ribs; it is inserted into the usual ridge on the humerus. In the Phalanger the muscle similarly detaches a dorsi epitrochlear muscle; and the parts are similar in the Wallaby and the Giant Kangaroo.

The pectoralis major in the Wombat arises from the sternum, from the sternal half of the clavicle, and from the upper six ribs, and is inserted into the pectoral ridge of the humerus; a separate portion exists underneath, which extends from the manubrium sterni and from the cartilage of the first rib to the head of the humerus, on a level above the last: these two portions are quite separate from each other; but I think they are only separate factors of the great pectoral. A similar band I found in the Badger, in which a fasciculus beneath the great pectoral passed from the top of the sternum to the greater tuberosity of the humerus: this seems to correspond to the third portion of the great pectoral in the Hare, Rabbit, Guinea-pig, and Agouti. In *Sarcophilus* the muscle passes from the clavicle, sternum, and upper five ribs to the pectoral ridge of the humerus, and is undivided. The muscle is large and single likewise in the Giant Kangaroo (Meckel describes it as bilaminar) and in Bennett's Kangaroo. The Opossum and Phalanger displayed no sign of segmentation.

The pectoralis minor of the Wombat is a small thin muscle which lies beneath the last named and inferior to the second slip of the greater pectoral just referred to; it arises from the mesosternum, and is inserted into the outer part of the greater tuberosity of the humerus, the coraco-humeral ligament, and into the coracoid process. In *Sarcophilus* it is attached to the head of the humerus and the shoulder-capsule, and, more slightly than in the Wombat, to the coracoid process; and in this animal its origin is from the abdominal linea alba, lower ribs, and mesosternum. This muscle is joined to the greater pectoral as a deep inseparable lamina in the Giant Kangaroo and in *Macropus Bennettii*, or absent, according to Meckel and Prof. Haughton (Proc. R. I. A. 1866, p. 81). In the Phalanger and Opossum it is present and passes to the humeral head below the shoulder-capsule; it is similarly situated in the Bandicoot.

The subclavius muscle exists under the form of a sterno-scapular band, arising fleshy from the first rib, and passing beneath the clavicle to be inserted into its outer sixth, into the upper border of the acromion process, and into the entire length of the upper margin of the scapular spine. This muscle did not resemble the arrangement described by Prof. Rolleston (Trans. Linn. Soc. vol. xxvi. p. 626). In the Wombat examined by him the muscle arose thick and fleshy from the first rib, and was inserted into the outer end of the clavicle and, by means of the fascia covering the supra-spinatus muscle, into the whole length of the spine of the scapula; before its insertion it was joined by a fine tendon from a delicate muscular belly arising from the sixth costal cartilage, and homologous with the muscular fasciculus in the crocodile which runs from the second sterno-costal cartilage to the sternum, in series with the external oblique and outer intercostals. As I was acquainted with Prof. Rolleston's description, when dissecting the animal I looked most carefully for this curious arrangement, but was disappointed; for I saw no sign of any prolongation from below attached to the sub-clavius. The insertion of the rectus abdominis was clear and tendinous into the first rib; and the only other muscle whose fibres could have run into it from below was the rectus thoracis (*vide infrà*); but there was no sign of any fusion in our specimen. Professor Rolleston's specimen seems to have been a better-developed individual; but this union does not seem to be the invariable rule in *Phascolomys*. A union of the origin of the subclavius with the insertion of the rectus abdominis occurs in *Orycteropus* *; and in this animal also the muscle is a true sterno-scapularis, as also in the Porcupine. A sterno-scapular band exists in the Llama, Rhinoceros, Hippopotamus, Axis, and other non-claviculate mammals; but it is interesting, as bearing on the homologies of this muscle, that, except in a few rare cases as a human anomaly, it never coexists with the ordinary subclavius.

In *Sarcophilus* the subclavius passes from the first rib-cartilage to the clavicle, but is not traceable further. In the Virginian Opossum it runs from the first sterno-costal cartilage to the outer third of the clavicle and the acromion process. In the Phalanger its insertion is still more extensive, and in *Macropus giganteus* and *Bennettii* its insertion extends for the outer two-thirds of the clavicle. In none of these latter is its sterno-scapular continuation marked. From the considerations given above, I think we can scarcely regard the sterno-scapular as any thing but a variety of the subclavius.

The rectus thoracicus arises from the lower part of the sternum, as far as the summit of the mesosternum, by a thin aponeurosis, which becomes fleshy and is inserted into the second and third ribs external to their cartilages; no fibres arise from the sixth rib, nor are any inserted into the first. In *Sarcophilus* the insertion is prolonged into the four upper ribs from the sternum. This is the muscle which is considered by Professor Rolleston (and, I think, with some reason) serially continuous with the external oblique. I have called it rectus thoracicus temporarily, for want of a better name; but it is evidently not the same as the more superficial rectus thoracis of Turner.

The pectoralis quartus in the Wombat and *Sarcophilus* covers the side of the chest below the fifth rib, and is inserted into the pectoral ridge of the humerus. In the Kangaroo and Wallaby this muscle is very large and superficial, its lowest fibres blending with those of the panniculus carnosus, its hinder fibres with those of the latissimus dorsi, and its anterior ones with those of the great pectoral. It is smaller and more definite in the Phalanger, and most distinct and separate in the Opossum. (For an account of the synonyms of this muscle, see the Anatomy of *Bradypus tridactylus*, Ann. Nat. Hist. July 1869.) Professor Owen regards this muscle as a differentiated portion of the great pectoral; and Prof. Humphry, who has added another new name to the eight by which this

* Galton, Trans. Linn. Soc. vol. xxvi. p. 572.

muscle is known (calling it brachio-lateralis), regards it as an intermediate piece of the great superficial external muscular sheet between the pectoralis major and the latissimus dorsi—a conclusion which, I think, is warranted from its position. It is most powerfully developed in swimming animals, such as the seal and the otter, in which its action is very definite and important.

There was no lateral rectus thoracicus in any of the marsupials which I have dissected. The transversi thoracis, anterior and posterior, are weakly developed in *Sarcophilus*; the latter is distinct, though small, in the Wombat; and the former is present and well marked in *Macropus giganteus* and *Bennettii*.

The deltoid of the Wombat is divided into two parts: one of these (the clavicular) has been mentioned already in connexion with the trapezius. The scapular deltoid arises from the acromion process and scapular spine, and is attached to the deltoid crest on the humerus separate from the preceding; this crest is prominently marked, although the deltoid is not very large.

In the Tasmanian Devil the acromial deltoid is separate from the scapular, and the latter is a long narrow muscular band. There is no clavicular deltoid separate from the outer fibres of the acromial portion. An undivided clavicular and scapular deltoid occurs in the Giant Kangaroo and in *Macropus Bennettii*, more extensive in origin in the former than in the latter. It is similarly attached in the Phalanger and Virginian Opossum. In *Perameles* Professor Owen describes an accessory slip arising from the middle of the inferior costa of the scapula below the infraspinatus, and inserted into the upper part of the deltoid-crest of the humerus. I did not see this interesting aberrant accessory fasciculus in any of the other marsupials examined.

The supraspinatus is larger than the infraspinatus in the Wombat, the Phalanger, *Perameles*, *Sarcophilus*, and the Opossum; in the Giant Kangaroo they are about equal, while in Bennett's Kangaroo the infraspinatus is the larger. There are no points of importance relative to these muscles; they are attached to the capsule of the shoulder, but none of these capsular muscles perforate it. The supraspinatus is often larger in other animals than the infraspinatus, as in the Lion, Agouti, Guinea-pig, Rabbit, Hare, Rat, Llama, &c.

The teres minor is not distinct from the infraspinatus in the Wombat or *Sarcophilus*, but a distinct fascial band takes its place; in the Wallaby it is present and separate; but in *Macropus giganteus*, *Phalangista vulpina*, *Perameles lagotis*, and *Didelphys virginiana* it is not at all separable from the infraspinatus.

The subscapularis presents no feature of interest in the Wombat; its two series of fibres are blended very perfectly. In *Sarcophilus* it is small, and scarcely covers two-thirds of the subscapular fossa. It is large in the Giant Kangaroo, proportionally still larger in Bennett's Kangaroo, and moderate in the Phalanger, Opossum, and Bandicoot. There is no subscapulo-humeral muscle in any of these marsupials separate from the subscapularis proper.

The teres major is large in the Wombat, and is attached to the lower half of the axillary costa of the scapula; some fibres of the inner head of the triceps are continuous with its fibres of insertion. It is also well developed in the native "Devil," much smaller in the Opossum, Phalanger, *Macropus giganteus* and *Bennettii*.

The coraco-brachialis is extremely small and rudimentary in the Wombat, consisting of a fleshy fascicle inserted immediately below the inner tuberosity of the humerus; it is closely applied to the subscapularis and capsule of the shoulder; and its origin, which is tendinous, is at first united to the tendon of the biceps. In *Sarcophilus* it arises by a tendinous flat band from the tip of the coracoid process, and is inserted into the neck of the humerus above the latissimus dorsi tendon; it is also closely applied to the surface of the subscapularis. In *Macropus giganteus* its origin is from the anterior border of the small coracoid process, in a line continuous forwards from the origin of the omo-hyoid; its insertion is similar to that above described, and is continuous with the upper fibres of the triceps internus. In *Macropus ruficollis* it is divided into two fascicles; but both these represent the short muscle of Mr. Wood. It is similar in its nature, but is small, short, and tendinous for two-thirds of its length, in the Opossum and Phalanger.

The biceps in all the marsupials is a double muscle; and the division is easily seen, either in the origin or in the insertion, in all the instances which have come under my notice. In the Wombat the muscle has two distinct tendons of origin, one coracoidal and one glenoidal; from these, two bellies descend the arm, slightly fused but capable of easy separation upon tearing; the fibres of the coracoidal origin pass to be inserted into the radius at its tubercle, those of the glenoidal portion seek an ulnar insertion in front of the insertion of the brachialis anticus. In *Sarcophilus* two tendons of origin exist, united, however, by a thin membranous expansion; but on dividing this and gently pulling asunder the two main tendons, a division into coraco-radial and gleno-ulnar portions can be made without difficulty. In *Macropus giganteus* the portions are distinct, and the gleno-ulnar muscle unites at its insertion, as described by Prof. Owen, with the brachialis anticus; the same occurs in *Macropus Bennettii*, in the Phalanger, and in the Opossum, in all of which the coraco-radial muscle is nearly double the size of the gleno-ulnar. Mr. Galton mentions that one individual of *Macropus Bennettii* had only a single head to its biceps; but this is, I think, an individual variety, as the four individuals of this group dissected in Dublin had two heads: but even in this case the duality of the muscle is shown by its double (radial and ulnar) insertion. Meckel describes the insertion of the gleno-ulnar muscle as separate from that of the brachialis anticus. In the specimen which I examined they were scarcely separable. The connexion between the tendons in *Sarcophilus* might at first sight have led to their having been considered but one head; however, a closer examination at once decided the duality of the origin. This union is interesting as bearing upon the important point suggested by Prof. Humphry, that, as the portion of the glenoid cavity from which the long head of the biceps arises is in reality coracoidal, so both heads of this muscle are truly coracoidean in their origin. Professor Owen (Anatomy of Vertebrates, vol. iii. p. 12) states that in *Perameles* the coracoidal head is suppressed, and also that the fleshy belly is inserted along with the brachialis internus into the ulna, while another portion seeks the radius—thus showing that, while the origin is single, the muscle in reality is double. Meckel only found one head for this muscle in *Macropus giganteus*.

The brachialis anticus in the Wombat was as usual in its position and attachments, winding round the bone below and external to the deltoid-crest, lying in a deeply excavated sulcus in the humerus; its insertion is behind the attachment of the gleno-ulnar muscle, and quite separate from it. Its position is similar in *Sarcophilus*, the Bandicoot, Opossum, Phalanger, Bennett's and Giant Kangaroo.

The triceps longus is large, and occupies more than a third of the axillary margin of the scapula. It is equally well developed in the Tasmanian Devil, the Wallaby, the Giant Kangaroo, the Opossum, Bandicoot, and Phalanger.

The lateral heads are united into one large humeral muscle, inseparable from each other, and with the usual course and attachments, in all the marsupials. The dorsi epitrochlear in all is quite separate from the true triceps, and seeks its usual insertion into the inner side of the olecranon. The relation of this dorsi epitrochlear to the sartorius I have elsewhere suggested; and in the light of the modification of the last-named muscle in the sloth (Ann. & Mag. Nat. Hist. July 1869), in which the origin of the muscle is tendinous from Poupart's ligament, and not from the bone, the homology is still more striking.

A subanconeus, from the lower sixth of the humerus to the synovial membrane of the elbow-joint, is present in the Tasmanian Devil; but I have not found it in any of the others.

The pronator radii teres in the Wombat is well developed, and passes from the inner condyle to the lower half of the radius. In *Sarcophilus* it is smaller, and is attached to the middle third of the radius. In the Opossum and Phalanger it resembles the last in disposition; but in *Macropus giganteus* and *Bennettii* it is inserted into the upper third of the radius. No coronoid slip was present in any of these marsupials.

The pronator quadratus was very weak in the Wombat, and occupied the lower third of the forearm. In *Sarcophilus* it extends for one-half, but is very thin, and occupies very little of the surfaces of the radius and ulna, merely lying in the space intervening between the bones. In *Macropus Bennettii* and *giganteus* it extends for rather more than the lower four-fifths of the interosseous space; it is similar in the Opossum as well as in the Phalanger and *Perameles*.

The flexor carpi radialis in the Wombat passes from the inner condyle to the second metacarpal bone. In *Sarcophilus* it sends an additional slip to the trapezium. In *M. Bennettii* it is inserted into the same bone or into the metacarpal bone of the thumb according to Prof. Haughton (P. R. I. A. 1866, p. 83). Its attachments are similar to those in the Wombat, in the Phalanger, Opossum, and Bandicoot.

The palmaris longus in the Wombat arises as usual, and is inserted by a flat tendon into the palmar fascia; it is present and similarly arranged in *Perameles lagotis*, *Macropus giganteus* and *Bennettii*. The palmaris accessorius, the commonest anomaly of this muscle in human anatomy, exists along with the true palmaris longus in the Wombat; and, like a very common human variety of the muscle (figured in the 'Proceedings of the Royal Irish Academy,' vol. ix. pl. 8. fig. 2), it arises by a flat tendon from the inner condyle; this soon becomes fleshy, and ends in a tendon which, passing through a special groove in the annular ligament, is inserted into the pad in the palm of the hand. This is the variety of the muscle existing in *Sarcophilus*, the Opossum, and Phalanger.

The flexor carpi ulnaris in the Wombat arises by two heads

—one from the internal condyle, and one from the olecranon process; this muscle is inserted into the fifth metacarpal bone. In *Sarcophilus* it is also bicipital, and is inserted into the pisiform bone, sending a slip (ulnaris quinti digiti) to the first phalanx of the little digit. This muscle is very large in the Opossum and Phalanger; it has no condylar origin in the Great Kangaroo and Wallaby.

The flexor sublimis digitorum arises in the Wombat from the inner condyle, inseparable from the profundus; but its tendons are small and separate, and lie on the surface of the deep flexor tendons; they pass to the fingers, and are perforated by the deep flexor; they terminate in the digital aponeuroses at the base of the first phalanges. In *Sarcophilus* there are three portions in the flexor muscle, and the superficial of these is the flexor sublimis; the tendons of the sublimis are arranged exactly as in the Wombat. In the Wallaby the sublimis arises from the inner condyle inseparably united to the profundus; but from the tendon of the common flexor above the wrist the fleshy fibres of the sublimis arise and form a lower belly, which sends tendons to all the fingers but the first. This arrangement can be understood in the light of the digastric modification of the flexor sublimis found in *Loris* and described as an anomaly in human anatomy. The muscle is quite distinct in the Opossum, and has perforated tendons.

The flexor profundus and flexor pollicis longus are more or less united in all. They are comparatively separate at their origin in *Sarcophilus*, but indivisible in the Wombat and Wallaby. The tendons in all are five, and pass to the five toes.

The supinator longus is rudimentary in *Sarcophilus*, and is represented by a band of superficial muscular fibres arising from the fascia over the deltoid muscle, and very slightly from the supinator-ridge of the humerus inserted into the fascia over the thumb. In the Wombat it is also superficial and thin, fascial in origin mainly and in insertion exclusively. In the *Macropus Bennettii* it is larger, and has a bony insertion into the metacarpal bone of the pollex. In the Giant Kangaroo it is purely bony in attachments, and is inserted into the trapezium and pollex. In the Opossum and Phalanger it is inserted into the trapezium and external lateral ligament of the wrist.

The extensor carpi radialis is a single muscle in *Macropus Bennettii*, the Wombat, *Sarcophilus*, Phalanger, and Giant Kangaroo, and is inserted into the bones of the second and third metacarpals. In the Opossum it has a single tendon only.

This possibly may be the muscle described by Professor Owen in *Perameles* as supinator longus, which "is inserted by one of its divisions into the base of one of the metacarpal bones of the index finger, and by the other into the adjoining metacarpal bone," as this is similar to the arrangement of the extensor carpi radialis in *M. Bennettii*, to which a separate supinator is superadded.

The extensor digitorum communis arises from the outer condyle, and is inserted into the second, third, fourth, and fifth toes in the Wombat, *Sarcophilus*, Opossum, *Phalangista*, Wallaby, and Giant Kangaroo.

The extensor digitorum secundus (extensor minimi digiti of anthropotomy) is normal in origin and supplies tendons to the fourth and fifth toes in the Wombat, to the third, fourth, and fifth in *Sarcophilus* (and of these the latter two are double), to the third, fourth, and fifth in Bennett's and the Giant Kangaroo, to the fourth and fifth in the Opossum and Phalanger.

The extensor carpi ulnaris has a double origin, from the ulna and outer condyle, and is inserted into the fifth metacarpal, in the Wombat; it has no ulnar origin in the Tasmanian Devil, Opossum, or Phalanger, but has one in Bennett's and the Giant Kangaroos, as well as in *Perameles*.

The anconeus externus of the Wombat is distinct and fan-shaped, and separate from the triceps. In the Devil it is united to the triceps, and extends down from the upper fifth of the ulna. It is distinct in the Opossum, Phalanger, Giant Kangaroo, and *Macropus Bennettii*.

The anconeus internus is round and more distinct than the externus in all the marsupials, and, in all, crosses over the ulnar nerve. This muscle is even more distinct in the majority of animals than the last.

The extensor ossis metacarpi pollicis is large in all, and runs from the whole of the back of the ulna and interosseous membrane to the trapezium and metacarpal bone of the thumb; it crosses the extensor carpi radialis tendon; and in the Opossum and Phalanger it extends over the supinator longus tendon also.

The extensor primi internodii is absent in all. The extensor secundi internodii in *Sarcophilus* and the Wombat passes from the lower third of the ulna to the last phalanx of the pollex; it is present and similar in all the other marsupials, and also in the Monotremes *Echidna hystrix* and *Ornithorhynchus paradoxus*, in both of which the extensor ossis metacarpi pollicis and primi internodii pollicis are both absent.

The extensor indicis is absent in the Wombat, but in

Sarcophilus extends from the lower end of the ulna to the index, middle, and ring fingers, completing thus the third group of extensors for the digits. A small slip passes from it to the thumb, similar to the extensor pollicis et indicis of the Dog.

The supinator brevis occupies the upper two-thirds of the radius in the Wombat, the upper third in *Sarcophilus*, the Wallaby and Giant Kangaroo, and the upper fourth in the Opossum; in all it has a condylar origin. In none of these does its insertion reach to such an extent as in *Echidna hystrix*, in which it occupies the entire length of the radius, and balances the pronator radii teres.

The abductor pollicis is very small in *Phascolomys*, is moderate in size in *Sarcophilus*, but, as a rule, small in the other marsupials, except in the Opossum—in which all the thumb-muscles are particularly well developed, an opponens pollicis being present in it, although suppressed in all the other marsupials which I have dissected.

The palmaris brevis in the Wombat is absent; but in the Tasmanian Devil a slip representing it arises from the pisiform bone, and is lost over the tendons of the flexor muscle of the digits. In no animal have I seen this muscle so curiously displaced as in *Echidna hystrix*; for in a fine specimen of this animal dissected by Professor Haughton and myself, December 29, 1869, this muscle, or a small one like it, arose from the ulna for a quarter of an inch above its lower end, and was lost in the fascia over the tendons of the wrist.

The lumbricales are four in number in the Wombat and *Sarcophilus*, one passing from the flexor tendon to the pollical side of each digit; they are similarly arranged in *Phalangista*, *Perameles*, and *Didelphys*.

The palmar interossei in the Wombat and *Sarcophilus* are four in number:—the first, or Henle's interosseus primus volaris; the second, to the ulnar side of the index; the third, to the radial side of the annularis; the fourth, to the radial side of the little finger. The dorsal interossei are five in number:—first, abductor of the index, from the first and second metacarpal to the first phalanx of the index; second, from the second and third metacarpals to the middle finger; third, from the third and fourth to the middle finger; fourth, from the fourth metacarpal to the ring-finger; and fifth, from the fifth metacarpal to the little finger; this last is extremely small in the Wombat—indeed, reduced to an excessively delicate thread.

The external oblique arises, in the Wombat, *Macropus*, and *Phalangista*, from the eight lower ribs and lumbar fascia, and, passing inward, is inserted into the border of the ilium, into the outer border of the marsupial bone, and into the linea alba. From the iliac spine to the root of the marsupial bone there runs in the lower border of this muscle a tendinous band, at which the femoral fascia lata splits, and which arches over the femoral vessels: this evidently is the true Poupart's ligament. A similar arrangement exists in *Sarcophilus*; the external abdominal ring intervenes between the Poupart's ligament and the marsupial bone.

The pyramidalis arises from the inside of the marsupial bone, and is inserted into the median line for a considerable extent. The rectus in *Sarcophilus* and the Wombat arises from the pubis inside the marsupial bone, and is inserted into the cartilage of the first rib, but was not connected to the subclavius. In *Sarcophilus* it extends up to the summit of the sternum; its inscriptions are clear and distinct.

The transversalis and internal oblique muscles are normal in every respect.

The quadratus lumborum is a wide triangular muscle in the Wombat, arising from the posterior third of the iliac crest and from the ilio-lumbar ligament, and is inserted into the transverse processes of the lumbar vertebræ and, by a few fibres, into the last rib. A small portion of it springs from the upper transverse processes and passes also to the last rib.

The gluteus maximus in the Wombat is united to the agitator caudæ, and arises from the posterior margin of the crest of the ilium and lumbar fascia, and is inserted into the outer and back part of the great trochanter. In *Sarcophilus* its course is similar, but it is separate from the agitator caudæ and lies beneath it. In *Macropus Bennettii* it is divided into two—one anterior, from the front of the iliac crest, and one posterior, from its usual site of origin: they are with difficulty separable; but the anterior is properly the tensor vaginæ femoris. The same separation is present in the Giant Kangaroo; and the posterior border is with difficulty separable from the agitator caudæ: they are still more closely fused in the *Phalangista vulpina* and also in *Didelphys virginiana.*

The gluteus medius is with difficulty separated from the gluteus minimus, and is very large in the Wombat; it is smaller in *Sarcophilus*, and in both displays nothing unusual in its attachments: they are quite separable in *Macropus giganteus* and *ruficollis*, also in the Opossum, Phalanger, and *Perameles.*

The agitator caudæ is separate from the external gluteus in *Sarcophilus*, and arises from the posterior border of the crest of the ilium by a very few fibres, also from the sacrum and three anterior caudal vertebræ; passing superficial to the gluteus medius, it is inserted into the femur at the posterior and external part of the great trochanter. In *Macropus Bennettii* it arises from the upper three caudal vertebræ, and is closely united to the gluteus maximus. In the Giant Kangaroo, *Phalangista*, and *Didelphys* it is similar, but less easily separated from the gluteus maximus.

The gluteus minimus is hardly separable from the medius in *Sarcophilus*, less so in the Wombat, but quite distinct in the Giant Kangaroo, Wallaby, *Phalangista*, Opossum, and *Perameles*.

The gluteus quartus in the Wombat arises from the outer side of the anterior inferior spine of the ilium, external to the origin of the rectus, and is inserted into the front of the great trochanter. In *Sarcophilus* the attachments are similar, and the muscle is very distinct. In the Giant Kangaroo it arises below and in front of the gluteus minimus and behind the rectus femoris, and is inserted below the summit of the great trochanter; it is flat and cleft into two parts in *Macropus Bennettii*, which are nearly equal; it is also present in the Phalanger, but small; it is more distinct in the Opossum.

The pyriformis muscle is a slip separated from the gluteus medius by the gluteal nerve, and arises inside the pelvis from the front of the sacrum, and is inserted into the summit of the trochanter; it is separate in the Wombat and *Sarcophilus*, but not nearly so large proportionally as in *Macropus giganteus*, *ruficollis*, or *Bennettii*; it is small and distinct in the Opossum, but undistinguishable from the gluteus medius in *Phalangista*; it is larger and separable in the Bandicoot (*Perameles lagotis*).

No obturator internus exists in the Wombat or *Sarcophilus*; but a large gemellus inferior is present in both, running from the tuber ischii to the digital fossa within the trochanter. In the *Macropus giganteus* and *Bennettii* the gemelli are also large, and extend into the pelvis, occupying all the space above the tuberosity of the ischium and below the obturator foramen, as far forward as the ascending ramus of the ischium: it is thus a rudimental obturator. This muscle is still smaller in the Phalanger, but more distinct, though small, in the Opossum.

The obturator externus is very large and normal in *Phascolomys* and *Sarcophilus*, as well as in *Macropus giganteus*, the Wallaby, Phalanger, and Opossum. Meckel says there is no obturator internus or gemelli in the Kangaroo, but that they are present in the Opossum.

The quadratus femoris is absent in the Wombat, and present only as a partially differentiated slip of the adductor magnus in *Sarcophilus*; it is large and distinct in the Kangaroos, and forms a powerful "tie-beam" between the ischium and femur, on which latter is a special tubercle for its reception; it is smaller in the Opossum and Phalanger, and thus seems to be specially developed in those marsupials with disproportional length of the fore and hind limbs.

The iliacus internus, a large muscle, arises in the Wombat and *Sarcophilus* from the entire iliac fossa and anterior margin of the ilium; it is inserted into the ridge below the lesser trochanter. There is no ilio-capsular in either of these marsupials; it is closely attached to the psoas, as is the case also in the *Macropus Bennettii*. Separation is more readily effected in the *Macropus giganteus* and Opossum, but not so freely in the phalanger or *Perameles*.

The psoas parvus in the Wombat is a weak muscle, but has a strong tendon; its origin extends over four vertebræ. It is rather stronger in *Sarcophilus*, but reaches its greatest development in the leaping kangaroos, being more than six times as large as the psoas magnus in the Giant Kangaroo, and twice as large as the psoadiliacus in the Wallaby; it is only one-third as large in the Phalanger, and still smaller in the Opossum. Thus the disproportion is only associated with leaping, and not with the marsupial type of muscles.

The psoas magnus in the Wombat arises from all the lumbar and from the last dorsal vertebræ, and is inserted along with the iliacus. In *Sarcophilus* its origin extends a vertebra higher; in the Giant Kangaroo it is attached to the lower two or three lumbar vertebræ, as is also the case in *Macropus Bennettii* and *Perameles lagotis*.

The coccygeus is small and distinct in both the Wombat and *Sarcophilus*, and is larger in *Macropus giganteus* and the Wallaby.

The rectus femoris is a distinct muscle, as usual, with a single marginal origin from the anterior inferior spine of the ilium, in *Sarcophilus*, Wombat, *Macropus giganteus* and *Bennettii*, *Phalangista vulpina*, and Virginian Opossum. Professor Owen, however, describes this muscle in *Perameles lagotis* as having two origins which are very distinct from each other.

The vastus externus is large in the Wombat, and is with difficulty separated from the vastus internus; it is even less distinct in the *Sarcophilus*, but in the Giant Kangaroo it is readily separable. In the *Macropus Bennettii* its origin receives an accessory fasciculus from the fascial insertion of the gluteus maximus and tensor vaginæ femoris.

The vastus internus in all is smaller than the externus, and can be separated even from the cruræus in *Macropus Ben-*

nettii. In *Macropus giganteus* it is, however, inseparable from the cruræus; but in *Phalangista*, *Perameles*, *Didelphys*, *Sarcophilus* and *Phascolomys* it is nearly inseparable from the externus.

The patella is mentioned as absent in the Wombat by Sir E. Home (Phil. Trans. vol. xcviii. 1808, p. 304); in reality it is present, but cartilaginous.

The popliteus in the Wombat and *Sarcophilus* is very large, but thin, arising from the upper third of the back of the fibula and inserted into the lower two-thirds of the back of the tibia, separate from the transverse tibio-fibular muscle to be hereafter described. A few fibres of this muscle in *Sarcophilus* are attached to the sesamoid bone in the outer head of the gastrocnemius. This muscle is smaller in the Giant Kangaroo, but in this and *Macropus Bennettii* its origin is purely sesamoid.

The adductor longus arises, in the Wombat and *Sarcophilus*, from the crest of the pubis, and is inserted into the middle third of the femur. The adductor brevis and magnus are rarely separable in either *Sarcophilus* or Wombat. In the Giant Kangaroo the three are easily separable, as also in the Wallaby. The adductor brevis is scarcely distinguishable from the adductor magnus in the Opossum, and less so in *Phalangista*. These muscles are always separate from the pectineus, internal and posterior to which they lie; the three portions are most distinct in the Opossum.

The pectineus is a small muscle, but double in the Wombat; the inner part passes from the spine of the pubis and marsupial bone to the line leading from the lesser trochanter to the linea aspera; a second portion passes close to the insertion of the psoas and iliacus external to the last. This muscle is similarly double in *Sarcophilus*; it is single in the Giant Kangaroo, Opossum, and Phalanger, small and definite in each. The slip from the marsupial bone exists in all marsupials which have hitherto been dissected.

The semimembranosus is fleshy for its whole extent in the Wombat and *Sarcophilus*, and has its normal course from the tuber ischii to the upper and inner part of the head of the tibia; it is closely in contact with the adductor magnus in the Giant Kangaroo; and in the Wallaby its origin extends farther forward than usual; it is closely connected to the semitendinosus in its origin in the Virginian Opossum, but separate in *Phalangista vulpina* and *Perameles lagotis*.

The semitendinosus in both *Sarcophilus* and the Wombat is normal in its course, quite separate from its neighbours, and with no tendinous inscription; it is similar in the Phalanger, Opossum, *Perameles*, Giant Kangaroo, and *M. ruficollis*, in none of which is an inscription present. This appearance was carefully searched for in all cases, but I could see no trace of it. (In an Otter dissected by me, Jan. 1870, not only was an inscription well marked, but the muscle above it had two separate origins—one from the caudal vertebræ and the other from the ischium; and these united exactly at the intersection and formed one belly.)

The biceps in *Sarcophilus* arises from the tuber ischii and from the upper four caudal vertebræ beneath the agitator caudæ, and is inserted into the outside of the knee; in its caudal origin and fibular insertion it is similar to that of the agitator caudæ in *Ornithorhynchus*; but in this latter animal a distinct biceps underlies, which has a purely ischiatic origin. The insertion is fibular in *Sarcophilus*; and the muscle is very similar in its position and attachments in *Phascolomys*. In the Wallaby its origin is connected to that of the semitendinosus; its tendon extends down the leg into the fascia over the gastrocnemius.

A fourth hamstring (bicipiti accessorius of Haughton) underlies the biceps in *Sarcophilus*, which stretches from the caudal vertebræ to the fibula and fascia of the leg. This muscle is absent in the Wombat, in the Giant Kangaroo, Bennett's Kangaroo, Phalanger, and Opossum; it is the longest muscle in the body of *Sarcophilus*, as is usually the case in animals in which it exists. Professor Owen describes it as present in the Kangaroo, and mentions that it is inserted with the biceps by two fasciculi into the outer condyle of the femur and the fascia over the gastrocnemius.

The gracilis arises in the Wombat and *Sarcophilus* from the symphysis and descending ramus of the pubis, and is inserted into the inside of the knee-joint; it is a strong muscle; it has an attachment to the marsupial bone in these as in all the other marsupials which I have examined.

The sartorius in the Wombat, *Phalangista*, *Macropus giganteus*, Wallaby, and *Dasyurus macrurus* arises from the anterior superior spine of the ilium, and is inserted into the inner side of the patella. In *Sarcophilus* its origin is extended inward along Poupart's ligament, as in *Bradypus tridactylus*. In *Perameles* it is nearly parallel to the rectus femoris.

The tibialis anticus in the Wombat passes from the outer surface of the tibia to the entocuneiform bone; it is well marked and presents nothing unusual in its appearance in the Virginian Opossum or in the Phalanger. In the Giant Kangaroo it is large, and its tendon is inserted into the base of the metatarsal bones of the two inner toes. This segmentation is carried a step farther in *Sarcophilus*, and a portion of the anterior tibial muscle is separated and detaches a weak tendon to the second metatarsal. The tendon from the single muscle-belly goes to the two metatarsals in *Macropus Bennettii*; but the muscle is much smaller proportionally than in the Giant Kangaroo. The tendon is also double in *Perameles lagotis*, and is attached to the middle and inner cuneiform bones.

The extensor digitorum longus arises from the fibula and from the front of the tibia, and is inserted into the four toes in the Wombat and *Sarcophilus*. In the Phalanger and Opossum its tendons are similarly disposed; but in Bennett's and the Giant Kangaroo it is distributed only to the third and fourth toes by distinct tendons.

The extensor brevis digitorum is present in all the marsupials which I have examined, and passes from the outer side of the tarsus to be inserted into the inner pair of toes.

The extensor hallucis in *Sarcophilus* is small and obliquely placed between the tibialis anticus and the extensor digitorum; it is inserted into the inner toe, together with the inner tendon of the short extensor. In the Wallaby it is inserted into the inner pair of toes by fine tendons. In the Phalanger and the Opossum it is also inserted into two toes. The Wombat possesses this muscle; but it is very small, and goes only into one toe.

The gastrocnemius externus in the Wombat, Giant Kangaroo, *Sarcophilus*, and Bennett's Kangaroo arises from the sesamoid bone at the back of the external condyle of the femur, and is inserted into the tendo Achillis and by it into the back of the os calcis. In the Opossum the muscle arises from the outer condyle of the femur.

The gastrocnemius internus is very separate in all from the external muscle; it arises from the inner condyle and joins the tendo Achillis, and is inserted in common with the last; it is larger than the externus in the Wombat, but smaller in *Sarcophilus*. It has no sesamoid bone in any of the species examined.

The soleus has a fibular small origin in the Wombat, but, as usual, has no tibial head. *Sarcophilus* has also a fibular soleus. The same is true in the Opossum and Phalanger, the Wallaby and Giant Kangaroo.

The plantaris in the Opossum and *Perameles* is small, but separate, passing from the outer condyle to the outer side of the heel; but no plantaris exists in the Wombat. A distinct small muscle in *Sarcophilus* passes from the back of the external lateral ligament and from the head of the fibula, and passes down to the internal side of the calcaneum and into the plantar fascia.

The peronei in *Sarcophilus* are complex: the peroneus longus arises from the upper and anterior parts of the fibula, winds round the outer side of the calcaneum and the cuboid bone to be inserted into the first metatarsal. The peroneus brevis lies anterior to the long muscle, and arises nearly as high up; its insertion is into the metatarsal bone of the little toe. Arising in common with it is the peroneus quinti digiti, which is inserted into the last phalanx of the outer toe. Still further forward are two other peroneal muscles, which arise from the lower four-sevenths of the fibula by a common fleshy belly, and, winding round the back of the outer malleolus, pass forward to be inserted, one into the extensor aponeurosis of the fourth, and one into the third toe. There are thus five peronei present in this animal. In the Giant Kangaroo four peronei are present—a peroneus longus, a peroneus brevis, quinti, and quarti digiti. The same series exists in the Wallaby, Phalanger, and Opossum. In the Wombat the only muscles of this group present are the long and short peronei, with an accessory quinti tendon detached from the last for the first phalanx of the outer toe.

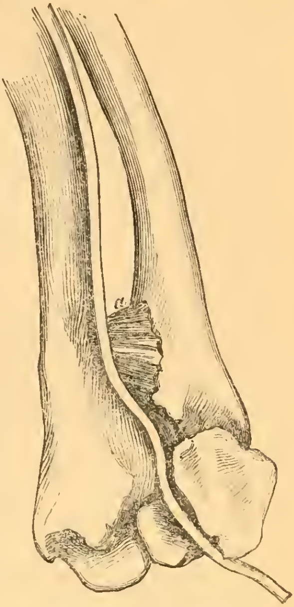
The Monotremes *Ornithorhynchus* and *Echidna* possess three peronei also.

The tibialis posticus arises in the Wombat from the back of the tibia, below the outer side of the head of the bone, and is inserted into the inner side of the scaphoid bone. In *Sarcophilus* it arises from the back of the fibula and tibia, and is similarly attached in the Wallaby and *Macropus major*. In the Opossum and Phalanger it is inserted into the base of the metatarsal bone of the hallux.

The flexor digitorum longus in the Wombat passes from the back of the tibia and fibula, and is in reality a compound of two parts, the flexor digitorum and the flexor hallucis; from the one belly five tendons pass, one to each of the toes. In *Macropus giganteus*, *M. Bennettii*, *Sarcophilus*, the Opossum, and Phalanger these muscles are similarly fused. In the Virginian Opossum a small slip, separate from this muscle and interposed between it and the tibialis posticus, passes to the metatarsal bone of the hallux, which may be a degraded flexor hallucis.

Professor Owen describes in *Dasyurus macrurus* a muscle which arises from the upper half of the back of the fibula, and, passing round the inner malleolus, is inserted into the plantar fascia; this muscle he regards as a degraded plantaris. There was no muscle corresponding to this in *Sarcophilus* or in any of the other marsupials dissected.

In both the Wombat and *Sarcophilus*, as well as in *Phalangista* and *Perameles*, there exists a transverse tibio-fibular muscle, homotypical with the pronator quadratus, quite separate from the prolonged popliteus, and similar to the transverse muscle of the Alligator, Crocodile, Iguana, and other reptiles: the muscle was described by Professor Owen as an aborted flexor digitorum communis longus; but a careful study of its properties would scarcely confirm this view. When considered in relation to the perineo-calcanean muscle of human anatomy, its position with regard to the quadrate pronator seems to be definite. I append a sketch of this muscle as it exists in the Alligator, which is characteristic of its relationship.



Hind leg of Alligator.
a, pronator quadratus.

On the sole of the foot in the Devil and Wombat the following muscles are seen—abductor hallucis, abductor minimi digiti, showing nothing peculiar; and behind the last there lies a small abductor ossis metatarsi minimi digiti, in *Sarcophilus.*

The plantar interossei are three in number, attached respectively to the second, third, and fourth toes, from the corresponding metatarsal bone. The dorsal interossei are abductors of the first, second, and fourth digits, and have double origins.

XVII.—*Descriptions of three new Species of Birds from China.* By Robert Swinhoe, F.Z.S.

Family **Rallidæ.**

Porzana mandarina, sp. nov.

Crown, hind neck, and upper parts deep brownish olive, ruddy on the forehead. Throat pure white. Eyebrow, the whole face, neck, and breast to the middle of the belly ferruginous chestnut, mixed on the last with white. Belly, axillaries, and under tail-coverts light black banded with white; tibial feathers pure white. Quills and tail olive-brown, the outer feather of the former with its outer web white; feathers of the wing-coverts marked with narrow waves of white, with brown lower edgings. Bill olive-green, yellow at tip of lower mandible. Irides light brownish crimson. Legs ochreous yellow tinged with green; claws browner.

Length about 9 inches; wing 5·1; tail 2·4, of eight soft, slightly graduated feathers; bill to gape 1·2, to forehead ·9, depth at base ·35; bare part of tibia ·5; tarse 1·6; middle toe 1·6, its claw ·3.

The above description is taken from a male bird shot in spring, in company with a male *Porzana fusca* (Linn.), on the Canton River.

It differs from *P. ceylonica* (Gmel.) of Southern India in wanting the rufous on the crown and hind neck, by the white marks on its wing-coverts, in having a white edge to its outer quill, by its white tibial feathers, and by the absence of white on the inner quills.

Porzana euryzona (Temm.) of Singapore has white spots and bands on the wing-coverts and quills. The black belly-bands extend up to the breast. The crown and hind neck are red, and the bird generally is very rufescent and smaller. The British Museum has a third species from the Philippines, and a fourth from the Sula Islands.

Family **Paridæ**.

Genus Siva, Hodgson.

Siva torqueola, sp. nov.

Crown with broad longish feathers, greyish brown, each feather edged with bluish grey, and having a pale stem. From the base of the under mandible, under the eye, and round the nape runs a broad line of chestnut-brown, most of the feathers having a central white streak. Back, scapulars, and rump olive-brown, with shafts of most of the feathers of the two former whitish. Tail-coverts of a deeper hue. Under parts white tinged with bluish grey; tibials deep olive-brown, the same colour of a lighter shade marking the ventral flanks, and more slightly, and in the form of obscure bars, the sides of the breast. Vent-feathers blackish brown, with shafts and broad tips of white. Axillaries white, with a brown and white barred carpal edge. Under edges of quills pale salmon-colour. Wing-feathers hair-brown, margined with reddish olive, the three inner tertiaries having white shafts and margins. Tail deep hair-brown, the four outer rectrices being tipped with white increasing outwardly, and on the two outermost including the outer web. Bill light brown. Legs, toes, and claws brownish flesh-colour.

Length about 5 inches; wing 2·7; tail 2·4; bill to gape ·55, breadth at base ·22; tarse ·66. The tarse is thick, and the hind toe and claw strong; the other claws are smaller, cultrated, well curved, and sharp.

Wing. The third quill, which is slightly longer than the fourth, is the longest in the wing; the first is ·45 shorter, and the second ·1 shorter than the third.

Tail consists of twelve broad, greatly graduated feathers; the fifth and sixth rectrices are nearly equal in length; the first is ·72 shorter, the second ·35, the third ·2, the fourth ·1.

The two specimens from which this description is taken were obtained in the Tingchow Mountains, about 100 miles from Amoy (China).

Family **Brachypodidæ.**

Ixus Andersoni, sp. nov.

Crown composed of rather long, soft feathers, black, which colour runs under the eye, and from the base of the bill forms a short moustache. At the base of the lower mandible occurs a minute blood-coloured spot. Upper parts light brown, very pale on the cheeks. Throat and under-neck white. A band of light brown about half an inch in depth crosses the breast. Tibials the same colour. Under parts cream-colour, tinged with brown on the flanks. Vent light orange or golden yellow, a touch of the same appearing on the lower edge of the wing. Wing-feathers deep hair-brown, margined with light brown tinged with olive. Tail also dark hair-brown, narrowly tipped with white, which soon disappears from abrasion of the feathers. Bill and feet black. Iris deep brown.

Length about 7 inches; wing 3·4; tail 3·7; bill to forehead ·53, to rictus ·7; tarse ·8. The sexes do not differ in colour or size.

I found this species common about Ichang, 1000 miles up the river Yangtse (China). Dr. Anderson of Calcutta procured the same bird on the western borders of the province of Yunnan, entering by the Burmese side. I saw his specimen in the collection he sent to England with Mr. Blanford; and as Dr. Anderson procured the species before myself, I feel in justice bound to dedicate it to him.

XVIII.—*Prodromus of a System of the Calcareous Sponges.* By Ernst Häckel †.

Note.—J. = Johnston. Bb. = Bowerbank. O. S. = Oscar Schmidt. M.-M. = Miklucho-Maclay. H. = Häckel. An * before the name of a genus or species indicates that it is new.

Legion CALCISPONGIÆ, Blainville.

(Synonyms: *Granticæ*, Fleming; *Spongiæ calcareæ*, Bowerbank.)

Sponges with a skeleton composed of carbonate of lime.

Order I. **MONOSYCA**, H.

Character. The mature calcareous sponge forms a single person with a single mouth-opening. (Body usually cylindrical, fusiform, or ovate, not branched. Stomachal cavity [inner cavity of the body] simple or chambered, always with a simple mouth-opening placed opposite to the point of adhesion.)

Family I. **Prosycida**, H.

Character. The mature calcareous sponge forms a simple sac-like person, furnished with a single mouth-opening, the body-wall (stomachal wall) of which is quite solid, and not perforated.

Genus 1. *Prosycum, nov. gen.

Gen. char. Mouth-opening simple, without any peristomial crown (without a circlet of projecting spicules). Two species.

1. **P. simplicissimum*, H. Naples (H.).
2. **P. primordiale*, H. Naples (H.).

Family II. **Olynthida**, H.

Character. The mature calcareous sponge forms a simple sac-like person furnished with a single mouth-opening, and the body-wall (stomachal wall) of which is perforated only by simple cutaneous pores. (The cutaneous pores are simple interstices in the parenchyma, without any special lining.)

Genus 2. *Olynthus, nov. gen.

Gen. char. Mouth-opening simple, without any peristomial crown (circlet of freely projecting spicules). Five species.

3. **O. simplex*, H. Naples (H.).

† Translated from the 'Jenaische Zeitschrift,' Band v. pp. 236–254, by W. S. Dallas, F.L.S.

4. *O. guancha*, H. (*Guancha blanca*, M.-M., var. A). Lanzarote (M.-M.).
5. *O. *cyathus*, H. Gibraltar (H.).
6. *O. pocillum*, H. (*Sp. pocillum*, Fab.). Greenland (Fab.), Norway.
7. *O. *hispidus*, H. Heligoland (H.).

Genus 3. *Olynthium, nov. gen.

Gen. char. Mouth-opening with a peristomial crown (surrounded by a peculiar circlet of freely projecting spicules). Two species.

8. *O. *nitidum*, H. Algoa Bay.
9. *O. splendidum*, H. Algoa Bay.

Family III. Sycarida, H.

Character. The mature calcareous sponge forms a simple sac-like person furnished with a single mouth-opening, and the stomachal wall of which is permeated by regular radial canals (radial tubes). (The radial tubes are lined with the vibratile entoderm, open at the distal end outwards through cutaneous pores, and at the proximal end through stomachal pores into the stomachal cavity, and communicate with each other on all sides by conjunctive pores.)

Genus 4. *Amphoridium, nov. gen.

Gen. char. Skeleton consisting merely of simple (linear) spicules. One species.

10. *A. viride*, H. (*Ute viridis*, O. S.). Cette (O. S.).

Genus 5. *Amphoriscus, nov. gen.

Gen. char. Skeleton consisting entirely of quadriradiate spicules: Three species.

11. *A. chrysalis*, H. (*Ute chrysalis*, O. S.). Lesina (O. S.).
12. *A. *urna*, H. Caraccas (Gollmer).
13. *A. *cyathiscus*, H. Australia.

Genus 6. *Sycarium, nov. gen.

Gen. char. Skeleton consisting of triradiate spicules in the walls of the radial canals, of quadriradiate spicules, the fourth ray of which projects freely into the stomachal cavity, in the wall of the stomach, and of simple, freely projecting, linear spicules at the distal ends of the radial canals. Mouth-opening simple, without thinly membranous rostrum or peristomial crown. Six species.

14. **S. ampulla*, H. Norway.
15. **S. rhopalodes*, H. Norway.
16. *S. compressum*, H. (*Grantia compressa*, J., var. A). England; Norway.
17. *S. utriculus*, H. (*Ute utriculus*, O. S., var. A). Greenland.
18. **S. villosum*, H. Antilles.
19. **S. vesica*, H. Messina (H.).

Genus 7. Syconella, O. Schmidt.

Gen. char. Skeleton of *Sycarium*. Mouth-opening produced into a thinly membranous rostrum (a canal not perforated by radial canals), and with no peristomial crown. Three species.

20. *S. quadrangulata*, O. S. Adriatic (O. S.).
21. **S. proboscidea*, H. Red Sea (Siemens).
22. **S. tubulosa*, H. Australia.

Genus 8. Sycum, Risso.

Gen. char. Skeleton of *Sycarium*. Mouth-opening with a simple peristomial crown (surrounded by a simple circlet of freely projecting spicules). Eighteen species.

23. *S. ciliatum*, H. (*Sp. ciliata*, Fabr.). Greenland; British coasts.
24. *S. arcticum*, H. (*S. raphanus*, var., O. S.). Greenland.
25. *S. coronatum*, H. (*Sp. coronata*, Ellis). England, Weymouth (Max Schultze).
26. *S. giganteum*, H. (*Grantia ciliata*, var., J.). Isle of Man; Britain.
27. *S. alopecurus*, H. (*Grantia ciliata*, var., Bb.).
28. *S. tessellatum*, H. (*Grantia tessellata*, Bb.). Channel Islands (Buckland).
29. *S. ananas*, H. (*Sp. ananas*, Montagu). Britain.
30. *S. ovatum*, H. (*S. ciliatum*, Lieberkühn). Heligoland.
31. **S. clavatum*, H. Norway (Schilling).
32. **S. lanceolatum*, H. Norway (Schilling).
33. **S. lingua*, H. Norway (Schilling).
34. *S. tergestinum* (*S. ciliatum*, O. S.). Trieste.
35. *S. raphanus*, O. S. Dalmatia (O. S.).
36. *S. capillosum*, O. S. Sebenico (O. S.).
37. *S. setosum*, O. S. Corfu (O. S.).
38. *S. Humboldtii*, Risso. Nice; Venice.
39. *S. inflatum* (*Sp. inflata*, Delle Chiaje). Naples (D.C.).
40. *S. petiolatum*, O. S. Desterro (Fritz Müller).

Genus 9. Dunstervillia, Bowerbank.

Gen. char. Skeleton of *Sycarium*. Mouth-opening with a double peristomial crown (surrounded by a double circlet of freely projecting spicules, an inner vertical and an outer horizontal one). Five species.

41. *D. elegans*, Bb. Algoa Bay (Bb.).
42. *D. corcyrensis*, O. S. Corfu (O. S.).
43. **D. Schmidtii*, H. Lagosta (O. S.).
44. **D. Lanzerotæ*, H. Lanzarote (M.-M.).
45. **D. formosa*, H. Barbadoes.

Genus 10. Artynas, Gray.

Gen. char. Skeleton as in *Sycarium*. Mouth-opening simple, without either proboscis or peristomial crown. Stomachal cavity chambered, traversed by irregular partitions. Four species.

46. *A. compressus*, H. (*Grantia compressa*, J., var. B). Norway.
47. *A. utriculus*, H. (*Ute utriculus*, O. S., var.). Greenland.
48. **A. rhopalodes*, H. Norway.
49. **A. villosus*, H. Antilles.

Genus 11. Ute, O. Schmidt (*p.p.*).

Gen. char. Skeleton consisting of triradiate spicules in the wall of the radial canals, of quadriradiate spicules, the fourth ray of which projects freely into the stomachal cavity, in the stomachal wall, and of simple linear spicules which lie parallel to the longitudinal axis of the body and, being packed closely together, form a firm external armour round the internal system of radial canals. Mouth-opening simple, without either proboscis or peristomial crown. Two species.

50. *U. glabra*, O. S. Lagosta (O. S.).
51. *U. ensata*, Gray (*Grantia ensata*, Bb.). Guernsey (Buckl.).

Genus 12. *Cyathiscus, nov. gen.

Gen. char. Skeleton consisting of triradiate spicules in the radial partitions of the perigastric chambers, of quadriradiate spicules, the fourth ray of which projects freely into the stomachal cavity, in the wall of the stomach, and of simple linear spicules which run parallel to the longitudinal axis of the body and, being packed closely together, form a firm external armour round the internal system of radial chambers. (The perigastric radial chambers, which surround the stomach in the same way as in the corals, are probably produced by the deficiency of the horizontal partitions which, in *Sycarium*, *Sycum*, &c., separate the superposed radial canals. Each perigastric chamber opens by a longitudinal series of stomachal pores into the stomachal cavity, and outwardly by several longitudinal rows of cutaneous pores.) Mouth-opening simple, without either proboscis or peristomial crown. One species.

52. **C. actinia*, H. Honolulu (Haltermann).

Family IV. **Dyssycida**, H.

Character. The mature calcareous sponge forms a simple sac-like person furnished with a single mouth-opening, and the stomachal wall of which is traversed by irregular ramified canals (parietal canals). (The parietal canals communicate repeatedly with each other, and open at the proximal end into the stomach by a few large stomachal pores, and at the distal end, outwardly, by very numerous small cutaneous pores.)

Genus 13. *Dyssycum, nov. gen.

Gen. char. Skeleton consisting of triradiate spicules in the body-wall, of quadriradiate spicules, the fourth ray of which projects freely into the stomachal cavity in the stomachal wall, and of simple, freely projecting spicules at the surface of the body. Mouth-opening simple, without either proboscis or peristomial crown. Five species.

53. *D. fistulosum*, H. (*Grantia fistulosa*, J.). British coasts.
54. *D. penicillatum*, H. (*Sycinula penicillata*, O. S.). Greenland.
55. *D. clavigerum*, H. (*Sycinula clavigera*, O. S.). Greenland (O. S.).
56. *D. solidum*, H. (*Grantia solida*, var. *solitaria*, O. S.). Dalmatia (O. S.).
57. **D. periminum*, H. Perim, Red Sea (Siemens).

Genus 14. *Dyssyconella, nov. gen.

Gen. char. Skeleton as in *Dyssycum*. Mouth-opening produced into a proboscis (a thinly membranous tube not traversed by parietal canals), without a peristomial crown. Two species.

58. *D. pumila*, H. (*Leuconia pumila*, Bb.). Guernsey (Norman).
59. **D. caminus*, H. Antilles.

Genus 15. Sycinula, O. Schmidt.

Gen. char. Skeleton as in *Dyssycum.* Mouth-opening surrounded by a peristomial crown (a simple circlet of freely projecting spicules). Three species.

60. *S. aspera*, O. S. Corfu; Dalmatia (O. S.).
61. *S. Egedii*, O. S. Greenland.
62. **S. echinata*, H. Algoa Bay.

Order II. **POLYSYCA**, H.

Character. The mature calcareous sponge forms a stock with several mouth-openings. (Body more or less branched, with the branches free or repeatedly united and anastomosed, forming sometimes little shrubs or bushes, sometimes a densely interlaced root-work or a spongy mass. Stomachal cavities of the persons composing the stock communicating with each other directly or indirectly, with a separate mouth-opening at the free end of all or of several branches (persons).)

Family V. **Soleniscida**, H.

Character. The mature calcareous sponge forms a stock with developed persons, each of which possesses a mouth-opening, and the stomachal walls of which are traversed by simple cutaneous pores, as in the Olynthida.

Genus 16. Leucosolenia, Bowerbank.

Gen. char. Stomachal cavities and their communicating tubes simple, not chambered. Mouth-openings of the persons simple, without either proboscis or peristomial crown. Twenty-one species.

Subgenus 1. *Leucalia.* Spicules all simple (linear). (The outer parts of the spicules project beyond the outer surface.)

63. **L. coralloides*, H., and
64. **L. troglodytes*, H. Naples (H.).

Subgenus 2. *Leucelia.* Spicules all triradiate. (Inner and outer surfaces of the tubes smooth.)

65. **L. dictyoides*, H. Australia.
66. *L. himantia*, H. (*Grantia botryoides*, var. *himantia*, J.). British coasts (J.).
67. *L. complicata*, H. (*Sp. complicata*, Montagu). British coasts (Mont.).
68. *L. guancha*, H. (*Guancha blanca*, var. B, M.-M.) Lanzarote (M.-M.).
69. *L. pulchra*, O. S. Dalmatia (O. S.).

Subgenus 3. *Leucaria.* Spicules partly simple (linear), partly triradiate. (The outer parts of the simple spicules project beyond the outer surface.)

70. **L. thamnoides*, H. Norway.
71. **L. robusta*, H. Naples (H.).
72. *L. Lieberkühnii*, O. S. Triest (O. S.).
73. *L. Fabricii*, O. S. Greenland (O. S.).

Subgenus 4. *Leuceria.* Spicules partly triradiate, partly quadriradiate. (The free ray of the quadriradiate spicules projects into the stomachal cavity.)

74. *L. botryoides*, Bb. (*Sp. botryoides*, Ellis). Britain (Bb.).
75. **L. Grantii*, H. British coasts.
76. **L. Darwinii*, H. British coasts.
77. **L. Goethei*, H. Naples (H.).
78. **L. Lamarckii*, H. Gibraltar (H.).
79. **L. Gegenbauri*, H. Messina (H.).

Subgenus 5. *Leuciria.* Spicules partly simple (linear), partly triradiate, and partly quadriradiate. (The free ray of the quadriradiate projects into the stomachal cavity, and the outer part of the simple spicules beyond the outer surface.)

80. *L. amœboides*, H. (*Grantia botryoides*, Lieberkühn). Heligoland.
81. **L. variabilis*, H. Norway.
82. *L. contorta*, Bb. British coasts (Bb.).

Subgenus 6. *Leucoria.* Spicules partly simple (linear), partly biradiate (hook-shaped), partly triradiate, and partly quadriradiate. (The free ray of the quadriradiate spicules projects into the stomachal cavity; the outer part of the simple and the outer limb of the hook-shaped spicules project beyond the outer surface.)

83. **L. echinoides*, H. Gibraltar (H.).

Genus 17. *Soleniscus, nov. gen.

Gen. char. Stomachal cavities and their communicating tubes chambered, traversed by irregular partitions and divided by them into numerous communicating chambers, in which the embryos are developed (as in *Clathrina*). One species.

84. **S. loculosus*, H. Australia.

Family VI. Tarromida, H.

Character. The mature calcareous sponge forms a stock with repeatedly interlaced anastomosing branches, and with rudimentary retromorphosed persons, the rudimentary stomachal cavities of which open in groups through common mouth-apertures.

Genus 18. *TARRUS, nov. gen.

Gen. char. Canals internally simple, smooth, with a plain entoderm, without papillæ or internal partitions. Five species.

85. **T. densus*, H. Australia.
86. *T. guancha*, H. (*Guancha blanca*, var. D, M.-M.). Lanzarote (M.-M.).
87. *T. reticulatus*, H. (*Nardoa reticulatum*, var., O. S.). Dalmatia (O. S.).
88. *T. labyrinthus*, H. (*Nardoa labyrinthus*, O. S.). Lesina (O. S.).
89. *T. spongiosus*, H. (*Nardoa spongiosa*, Köll.). Nice (Eberth).

Genus 19. *TARROMA, nov. gen.

Gen. char. Canal-walls internally villous, densely clothed with projecting papillæ (outgrowths of the entoderm). Three species.

90. *T. canariense*, H. (*Nardoa canariensis*, M.-M.). Lanzarote (M.-M.).
91. *T. rubrum*, H. (*Nardoa rubra*, M.-M.). Lanzarote (M.-M.).
92. *T. sulphureum*, H. (*Nardoa sulphurea*, M.-M.). Lanzarote (M.-M.).

Genus 20. CLATHRINA, Gray.

Gen. char. Canals chambered internally, *i. e.* broken up by irregular partitions (lamellar outgrowths of the entoderm) into numerous intercommunicating chambers, in which the embryos occur. Two species.

93. *C. sulphurea*, Gray (*Grantia clathrus*, O. S.). Sebenico (O. S.).
94. **C. loculosa*, H. Australia.

Family VII. **Sycodendrida**, H.

Character. The mature calcareous sponge forms a stock with developed persons, each of which possesses a mouth-opening, and of which the stomachal walls are traversed by regular radial canals (radial tubes), as in the Sycarida.

Genus 21. *Sycidium, nov. gen.

Gen. char. Mouth-openings simple, without proboscis and without peristomial crown. Stomachal cavities of the persons simple, not chambered. Skeleton as in *Sycarium*. Two species.

95. *S. gelatinosum*, H. (*Alcyoncellum gelatinosum*, Blainv.). Habitat? (Quoy & Gaimard).
96. **S. compressum*, H. (*Grantia compressa*, J., var. c). British coasts; Norway.

Genus 22. *Sycodendrum, nov. gen.

Gen. char. Mouth-openings without proboscis, with a peristomial crown (surrounded by a circlet of freely projecting spicules). Stomachal cavities of the persons simple, not chambered. Two species.

97. **S. ramosum*, H. Heligoland (H.).
98. **S. procumbens*, H. Australia.

Genus 23. *Artynium, nov. gen.

Gen. char. Mouth-openings simple, without proboscis or peristomial crown. Stomachal cavities of the persons chambered, traversed by irregular partitions. Skeleton as in *Sycarium*. One species.

99. *A. compressum*, Gray (*Grantia compressa*, J., var. d). Norway.

Genus 24. Aphroceras, Gray.

Gen. char. Mouth-openings simple, without proboscis and without peristomial crown. Stomachal cavities of the persons chambered, traversed by irregular partitions. Skeleton consisting of simple fusiform spicules, which run parallel to the longitudinal axes of the persons and of the branched stem, and, being closely packed together, form a firm external armour round the internal system of radial canals (?). One species.

100. *A. alcicornis*, Gray. Hong Kong (Harland).

Family VIII. **Sycothamnida.**

Genus 25. *Sycothamnus, nov. gen.

Gen. char. Persons of the stock separated, only connected by their peduncles. Mouth-openings simple, without proboscis or peristomial crown. One species.

101. **S. fruticosus*, H. Red Sea (Siemens).

Genus 26. Leuconia, Grant.

Gen. char. Persons of the stock united by the greater part of their body-wall; only their stomachal cavities and mouth-openings separated. Mouth-openings simple, without proboscis or peristomial crown. Five species.

102. *L. nivea*, Bb. (*Sp. nivea*, Grant). British coasts.
103. *L. Gossei*, O. S. (*Leucogypsia Gossei*, Bb.). Channel Islands.
104. *L. stilifera*, O. S. Greenland.
105. *L. algoensis*, H. (*Leucogypsia algoensis*, Bb.). Algoa Bay.
106. *L. solida*, O. S. (*Grantia solida*, var. *socialis*, O. S.). Dalmatia (O. S.).

Order III. **CŒNOSYCA**, H.

Character. The mature calcareous sponge forms a cœnobium (a stock composed of several persons with a single common mouth-opening). Body branched, with its branches everywhere coalescent and anastomosing, and finally running together into a single mouth-opening. (Rarely the persons also grow together externally to form a massy lump, as in *Cœnostomella.*)

Family IX. **Nardopsida**, H.

Character. The mature calcareous sponge forms a stock with a single mouth-opening, the canal-walls of which are only traversed by simple cutaneous pores (as in the Olynthida and Soleniscida).

Genus 27. Nardoa, O. S.

Gen. char. Mouth-opening simple, not produced into a thinly membranous proboscis. Two species.

107. *N. guancha*, H. (*Guancha blanca*, var. c, M.-M.). Lanzarote, (M.-M.).
108. *N. lacunosa*, O. S. (*Grantia lacunosa*, J.). British coasts.

Genus 28. *Nardopsis, nov. gen.

Gen. char. Mouth-opening produced into a long thinly membranous proboscis. Two species.

109. **N. gracilis*, H. Australia.
110. *N. reticulum*, O. S. (*Nardoa reticulum*, O. S.). Dalmatia, O. S.)

Family X. **Cœnostomida**, H.

Character. The mature calcareous sponge forms a stock with a single mouth-opening, the stomachal walls of which are traversed by irregularly branched canals.

Genus 29. *CŒNOSTOMELLA, nov. gen.

Gen. char. The persons of the stock are united into a single mass, the common mouth-opening of which is produced into a thinly membranous proboscis, whilst the stomachal cavities of the persons remain separated. One species.

111. **C. caminus*, H. Antilles.

Order IV. **CLISTOSYCA**, H.

Character. The mature calcareous sponge forms one person without a mouth-opening. (The body usually appears under the form of an ovate, spheroidal, or compressed bladder, the internal cavity of which communicates with the surrounding water only by cutaneous pores or parietal canals, but by no large orifice (mouth); the mouth is closed up.)

Family XI. **Clistolynthida**, H.

Character. The mature calcareous sponge forms a person without a mouth-opening, the wall of which is traversed by simple cutaneous pores (as in the Olynthida).

Genus 30. *CLISTOLYNTHUS, nov. gen.

Gen. char. Stomachal cavity simple, without partitions. One species.

112. **C. vesicula*, H. Honolulu (Haltermann).

Family XII. **Sycocystida**.

Character. The mature calcareous sponge forms one person without a mouth-opening, the body-wall of which is traversed by regular radial canals (radial tubes) as in the Sycarida.

Genus 31. *SYCOCYSTIS, nov. gen.

Gen. char. Stomachal cavity quite simple, without compartments. Three species.

113. **S. oviformis*, H. Heligoland (H.).
114. **S. compressa*, H. Norway.
115. *S. utriculus*, H. (*Ute utriculus*, O. S.). Greenland.

Genus 32. *ARTYNELLA, nov. gen.

Gen. char. Stomachal cavity chambered, traversed by irregular partitions. Three species.

116. *A. compressa*, H. Norway.
117. *A. rhopalodes*, H. Norway.
118. *A. utriculus*, H. (*Ute utriculus*, var., O. S.). Greenland.

Family XIII. **Lipostomida**, H.

Character. The mature calcareous sponge forms one person without a mouth-opening, the body-wall of which is traversed by irregular branched canals (as in the Dyssycida).

Genus 33. *LIPOSTOMELLA, nov. gen.

Gen. char. Stomachal cavity quite simple, without compartments. Two species.

119. *L. clausa*, H. Mogador (H.).
120. *L. capsula*, H. Algoa Bay (Poehl).

Order V. **COPHOSYCA**, H.

Character. The mature calcareous sponge forms a stock without a mouth-opening. (The body appears under the form either of a branching shrub or of a root-like network, in consequence of partial ramification, or, lastly, of a shapeless mass formed by the complete amalgamation of several persons. The stomachal cavities of the persons are always more or less separated, whilst their mouth-openings are obliterated.)

Family XIV. **Sycorrhizida**, H.

Character. The mature calcareous sponge forms a stock without mouth-openings, the canal-walls of which are traversed by simple cutaneous pores.

Genus 34. *SYCORRHIZA, nov. gen.

Gen. char. The mouthless stock forms a root-like network composed of communicating tubes, the inner wall of which is smooth (not villous), and their cavity simple (not chambered). Two species.

121. *S. coriacea*, H. (*Leucosolenia coriacea*, Bb.). British coasts.
122. *S. corallorrhiza*, H. Norway.

Genus 35. *AULORRHIZA, nov. gen.

Gen. char. The mouthless stock forms a root-like network composed of communicating tubes, the inner wall of which is villous (set with papillæ), and their cavity simple (not chambered). One species.

123. **A. intestinalis*, H. Mogador (H.).

Genus 36. *AULOPLEGMA, nov. gen.

Gen. char. The mouthless stock forms a root-like network, the ramifications of which are communicating tubes with a chambered cavity traversed by irregular partitions (outgrowths of the entoderm). One species.

124. **A. loculosum*, H. Australia.

Family XV. **Sycophyllida**, H.

Character. The mature calcareous sponge forms a stock without mouth-opening, the stomachal walls of which are traversed by regular radial canals (radial tubes) as in the Sycodendrida.

Genus 37. *SYCOPHYLLUM, nov. gen.

Gen. char. Stomachal cavities simple, not chambered. Two species.

125. **S. lobatum*, H. Norway.
126. **S. compressum*, H. Norway.

Genus 38. *ARTYNOPHYLLUM, nov. gen.

Gen. char. Stomachal cavities chambered, traversed by irregular partitions. One species.

127. **A. compressum*, H. Norway (H.).

Family XVI. **Sycolepida**, H.

Character. The mature calcareous sponge forms a stock without mouth-opening, the stomachal walls of which are traversed by irregular, ramified parietal canals (as in the Dyssycida).

Genus 39. *SYCOLEPIS, nov. gen.

Gen. char. The stock forms an expanded crust or a shapeless lump, in the parenchyma of which the simple (not chambered) stomachal cavities of the persons are scattered, only connected by the branched parietal canals and only opening outwards by the cutaneous pores. Two species.

128. **S. incrustans*, H. Norway (Schilling).
129. **S. pulvinar*, H. Indian Ocean (Schneehagen).

Order VI. **METROSYCA**, H.

Character. The mature calcareous sponge forms a stock, the constituent (mature) persons or groups of persons of which exhibit the forms of different genera and even of different families of the Calcispongiæ. (Notwithstanding that the persons united upon one cormus are mature (*i. e.* contain spores or embryos), and therefore capable of propagation, they present such diverse forms that, if isolated, we should regard them as belonging not merely to different species, but even to different genera and families.)

Family XVII. **Thecometrida**, H.

Character. The mature calcareous sponge forms a stock, the constituent persons of which represent the forms of different genera, whilst their canal-walls are traversed by simple cutaneous pores (as in the Soleniscida).

Genus 40. GUANCHA, M.-M.

Gen. char. Canals of the stock simple, neither villous nor chambered internally. One species.

130. *G. blanca*, M.-M. Lanzarote (M.-M.). (The stock in its most highly developed form bears united forms of four genera, namely:—1, *Olynthus*; 2, *Leucosolenia*; 3, *Tarrus*; 4, *Nardoa*.)

Genus 41. *THECOMETRA, nov. gen.

Gen. char. Canals of the stock chambered, internally traversed by irregular partitions. One species.

131. **T. loculosa*, H. Australia. (The stock in its most highly developed form bears united forms belonging to three genera, namely:—1, *Soleniscus*; 2, *Clathrina*; 3, *Auloplegma*.)

Family XVIII. **Sycometrida**, H.

Character. The mature calcareous sponge forms a stock, the constituent persons of which represent the forms of different genera, whilst their canal-walls are traversed by regular radial canals (radial tubes), as in the Sycodendrida.

Genus 42. *SYCOMETRA, nov. gen.

Gen. char. Mouth-openings of the persons simple, without proboscis or peristomial crown. Skeleton as in *Sycarium*. One species.

132. **S. compressa*, H. Norway. (The stock, in its most highly developed form, bears united forms of eight genera, namely :—1, *Sycarium*; 2, *Artynas*; 3, *Sycidium*; 4, *Astynium*; 5, *Sycocystis*; 6, *Artynella*; 7, *Sycophyllum*; 8, *Artynophyllum*.)

Synoptical Table of the Families of Calcispongiæ, *with especial reference to the conditions of individuality.*

I. Monosyca. Calcareous sponge one person with one mouth-opening.	Stomach-wall solid, without cutaneous pores and without parietal canals...	1. *Prosycida.*
	with simple cutaneous pores ...	2. *Olynthida.*
	with regular, radial parietal canals	3. *Sycarida.*
	with irregular, branched parietal canals	4. *Dyssycida.*
II. Polysyca. Calcareous sponge a stock with many mouth-openings.	with simple cutaneous pores (stock with developed persons)	5. *Soleniscida.*
	with simple cutaneous pores (stock with rudimentary persons)	6. *Tarromida.*
	with regular, radial parietal canals	7. *Sycodendrida.*
	with irregular, branched parietal canals	8. *Sycothamnida.*
III. Cœnosyca. Calcareous sponge a stock with one mouth-opening.	with simple, cutaneous pores ...	9. *Nardopsida.*
	with irregular, branched parietal canals	10. *Cœnostomida.*
IV. Clistosyca. Calcareous sponge one person without a mouth-opening.	with simple cutaneous pores ...	11. *Clistolynthida.*
	with regular, radial parietal canals	12. *Sycocystida.*
	with irregular, branched parietal canals	13. *Lipostomida.*
V. Cophosyca. Calcareous sponge a stock without mouth-opening.	with simple cutaneous pores ...	14. *Sycorrhizida.*
	with regular, radial parietal canals	15. *Sycophyllida.*
	with irregular, branched parietal canals	16. *Sycolepida.*
VI. Metrosyca. Calcareous sponge a stock composed of persons and stocks of various species and genera.	with simple cutaneous pores ...	17. *Thecometrida.*
	with regular, radial parietal canals	18. *Sycometrida.*

Synoptical Table of the Families of Calcispongiæ, *with especial reference to the conditions of canalization.*

I. Aporeuta. Stomach-wall solid, without cutaneous pores or parietal canals.	One person with one mouth-opening	1. *Prosycida.*

II. Microporeuta. Stomach-wall with simple cutaneous pores (interstices in the parenchyma), without parietal canals.	One person with one mouth-opening	2. *Olynthida.*
	A stock with many mouth-openings. Persons developed, all with mouth-openings	5. *Soleniscida.*
	A stock with many mouth-openings. Persons rudimentary, many without mouth-opening	6. *Tarromida.*
	A stock with one mouth-opening	9. *Nardopsida.*
	A person without mouth-opening	11. *Clistolynthida.*
	A stock without mouth-opening	14. *Sycorrhizida.*
	A stock composed of persons and stocks of diverse genera	17. *Thecometrida.*
III. Orthoporeuta. Stomach-wall with straight, regular, radial parietal canals.	One person with one mouth-opening	3. *Sycarida.*
	A stock with many mouth-openings	7. *Sycodendrida.*
	A person without a mouth-opening	12. *Sycocystida.*
	A stock without mouth-openings	15. *Sycophyllida.*
	A stock composed of persons and stocks of different genera	18. *Sycometrida.*
IV. Cladoporeuta. Stomach-wall with crooked, irregular, branched parietal canals.	One person with one mouth-opening	4. *Dyssycida.*
	A stock with many mouth-openings	8. *Sycothamnida.*
	A stock with one mouth-opening	10. *Cœnostomida.*
	One person without mouth-opening	13. *Lipostomida.*
	A stock without mouth-openings	16. *Sycolepida.*

XIX.—*On the Parasitism of* Rhipiphorus paradoxus. By T. Algernon Chapman, M.D.

I have read Mr. Murray's papers on the economy of *Rhipiphorus* with much interest; and although he has not succeeded in converting me to his views of its life-history, he has added to our knowledge of its habits and raised anew an interest in the relations subsisting between the wasps and their parasites which will probably lead to observations in the coming season that will set at rest many of the points in dispute.

In the meantime I think it very desirable to form as correct an hypothesis of the life of *Rhipiphorus* as our facts admit of, since an approximation to the truth is a most valuable guide in making further investigations, while, on the contrary, an erroneous theory may blind us to very obvious truths.

I cannot better begin the remarks I desire to make than by rendering what appears to me to be but justice to the accuracy of the earliest record we have of the economy of *Rhipiphorus*, meagre and deficient in detail though this record is. The observations of Mr. Denison, brought to our notice by Mr. Smith from the papers of the Ashmolean Society, appear to me to give an accurate sketch of the life-history of *Rhipiphorus*, and to be in harmony with all the facts yet recorded both of *Rhipiphorus* itself and of other parasites whose similar habits render their history fairly available in explaining that of *Rhipiphorus.* The account there given is that *Rhipiphorus* "deposits its egg upon the grub of the wasp at the moment it assumes the pupa (*i. e.* spins or covers itself in the cell); as soon as the egg is hatched, it devours the grub of the wasp entirely, and itself assumes the pupa- and imago-form in the cell of the wasp."

The mode of oviposition here noted of *Rhipiphorus* is, I believe, that followed by it, although it will be seen that I am here at issue not only with Mr. Murray, but also with Mr. Smith, with whom on all other points I agree. If Mr. Denison's view (but for the slight disagreement noted, I should here, as I shall in the rest of these remarks, have said Mr. Smith's view) of the history of *Rhipiphorus* is correct, the relation of *Rhipiphorus* to the wasp is, *mutatis mutandis*, precisely the same as that of *Chrysis bidentata* to *Odynerus spinipes.* The larva of *Chrysis bidentata* feeds on that of the solitary wasp, from whose cocoon emerges, not the wasp, but the *Chrysis.* Now in this instance the egg of the parasite is not laid until after the larva of the wasp has done feeding, and is spinning its cocoon. Before I ascertained this fact, I had formed the same theory as to the period of oviposition as Mr. Smith has done in the case of the *Rhipiphorus*, and made in consequence many a vain search for the egg of *Chrysis bidentata* beside the feeding larva of the *Odynerus.* The parent *Chrysis* has many more difficulties to overcome (what these are is not material to the present subject) in depositing her eggs than the *Rhipiphorus*, to whom it must be as easy to deposit an egg beside a full-fed larva, during or just before spinning, as in an empty cell. There are other instances recorded of parasites similarly depositing their eggs beside full-fed larvæ, none, that I know of, of an egg remaining dormant beside a feeding larva. Mr. Murray appears to interpret Mr. Smith's view to be that the larva of *Rhipiphorus* hatches at the same time as that of the wasp, and then walks off to find a full-fed larva to eat. I quite agree with Mr. Murray's comments on such a theory, but feel satisfied that Mr. Smith really meant that the egg lay dormant until its companion, the egg of the wasp, was a full-fed larva.

The two eggs found by Mr. Murray in some cells of the wasp both appear to me to be undoubtedly eggs of the wasp. I think it extremely improbable that the egg of *Rhipiphorus* should be precisely the same as, however similar it may be to, that of the wasp. I have found two eggs so situated in nests in which I could see no trace, unless this was one, of *Rhipiphorus*. I have seen two young larvæ of similar size in the same cell; yet afterwards one of these must have disappeared, removed probably by the wasps, and not devoured by the other grub, whether that may have been a *Rhipiphorus* or not. I may mention an exaggerated, because abnormal, instance of more than one egg being in each cell. I had placed some pieces of wasp-comb with many wasps clustered about them in a box, and so made an artificial nest. After a period I found every otherwise unoccupied cell with two, three, or more eggs in it, several with as many as twenty. The cause of this I cannot explain. Whether I had so diminished the amount of comb that there were not sufficient cells for the queen to deposit her eggs, one in each, or whether I had destroyed the queen, and some of the workers had assumed queenly functions, which is said sometimes to occur, and the latter had not the same accurate instincts as a true queen, I am unable to say. But whatever may have been in a morbid instance the cause of this multiplicity of eggs in the same cell may fairly be assumed to be a possible cause in a healthy nest.

My argument, so far, is rather against the supposition that the *Rhipiphorus*-egg is laid in the cell with that of the wasp, on the theory of the latter being the prey of the former (Mr. Smith's view). On Mr. Murray's hypothesis, the egg of *Rhipiphorus* might be laid in a cell by itself; but, if laid in one with a wasp-egg also, we must suppose that the latter, either before or after it is hatched, is removed by the attendant wasps, or falls a prey to the young *Rhipiphorus*-larva. In either case it is a necessary result of the theory that the larva of *Rhipiphorus* should be found occupying a cell among the wasp-larvæ. No one has ever pretended to have found a *Rhipiphorus*-larva so situated, though it has often been looked for. I pass over as untenable Mr. Murray's suggestion that some of his wasp-larvæ were *Rhipiphori*; I have myself searched in vain for such a larva in nests infested by *Rhipiphori*. I shall leave Mr. Smith to show (which I know he has the means of doing) that a larva of *Rhipiphorus* so situated differs sufficiently from that of the wasp to be readily detected, though I think Mr. Stone's remark, that "the larva is a singular-looking one," would of itself sufficiently establish this, especially when we take into account the fact that he nowhere hints at any possibility of confounding it with that of the wasp.

The remaining difficulty in the way of supposing the larva of *Rhipiphorus* to be reared in precisely the same way as those of the wasp, is the silken covering always found over the pupa of *Rhipiphorus*, just as over that of the wasp. I have never seen any difference between the silk covering a *Rhipiphorus* and that covering a wasp, though I have found it possible to guess the cell containing the beetle by the shining-through of the differently coloured inmate. It seems very probable, from what we know of the mimicry by guest-insects of their hosts, that its silk would closely resemble that of the wasp, did it spin silk at all. The only instances of beetles spinning any thing like silk, that I can call to mind, are *Cionus* and its allies, and the doubtful instances of *Coccinella* and *Donacia*.

In discussing the difficulties raised by Mr. Murray in the way of Mr. Smith's view of the economy of *Rhipiphorus*, I shall dismiss his objections to the supposition of the *Rhipiphorus*-larva devouring several wasp-larvæ, because I have no wish to defend such a theory, nor do I suppose that Mr. Smith has. But the objections he raises to the hypothesis of its devouring only one larva, viz. the one in whose cell the egg of *Rhipiphorus* is laid when the larva has done feeding, and is spinning or about to spin, all appear to me to be invalid. He first asks Mr. Smith if a meal of one animal can suffice to nourish another into as great dimensions as the animal eaten. Mr. Murray here stretches his point a little. The *Rhipiphorus* is not of as great dimensions as the animal eaten, although it is very nearly so. It is little if at all nearer to the dimensions of the wasp than *Chrysis bidentata* is to the dimensions of its host *Odynerus spinipes*, of which I have sufficiently proved it eats but one larva. Or I might put this in a still stronger form: *Chrysis neglecta*, differently from *C. bidentata*, eats not the wasp-larva, but the store of pabulum laid up for the larva of the *Odynerus*. It might certainly, then, so far as store of nutriment goes, be as large as the wasp; yet it is smaller than *Chrysis bidentata*, whose food is the larva of the wasp.

Mr. Stone found a "minute larva" grow to full size in forty-eight hours—on which Mr. Murray remarks that it is so opposed to every thing we know of the laws of development and assimilation that he cannot accept it. Now I am unable to give Mr. Murray any facts that will expand his faith in the laws of development and assimilation quite to the extent required; but I am able to give him some that will so nearly do so, that he will, I doubt not, like myself, be prepared to believe that Mr. Stone's account is literally true. I may first say that probably Mr. Smith felt little difficulty in accepting Mr. Stone's observations, as he must be accustomed to the rapid feeding-up which occurs in so many Hymenoptera. I, on the other hand, was as much astonished at my own observations on the *Chrysides* as Mr. Murray can be incredulous of the facts recorded by Mr. Stone. The larva of *Chrysis bidentata* began to spin its cocoon in eleven days from the date of the egg-hatching. *Chrysis neglecta* took rather a shorter time. But in one instance in which I reared a larva of *Chrysis ignita*, and happened to know the date on which the egg was laid, I found, two days after that date, a "minute larva" ($\frac{1}{4}$ inch long, about one-thirtieth of the full-grown larva in bulk), and in *four* more days the larva was full-fed.

On Mr. Murray's next point, as I have no fresh light to throw on it, I will merely remark that, as I read the recorded facts, the larvæ that Mr. Stone found unemployed in eating wasp-larvæ were not larvæ that had still some eating to do, but were those that had, as Mr. Murray expresses it, eaten up their man and retired from active life; though not yet pupæ, they were about to enter that state. All larvæ take a prolonged rest at this stage of their existence. Mr. Murray, who will not allow that a larva can feed up in two days (not from the egg, but from a small size), surely does not ask us to suppose that the larva becomes a pupa the instant it has done feeding. *Chrysis*, which fed up in four days, remains before its change to pupa nearly ten months. Will he not allow *Rhipiphorus* a day or two?

I do not see that the question of size has much bearing upon the question at issue. In the one view the large specimens are large because they have eaten a queen instead of a worker larva, in the other the wasps have fed them more plentifully because they were in queen-cells. Still, if the capacity of parasites for varying in size which Mr. Smith mentions be not called in by Mr. Murray to account for those in the queen-cells being able to assimilate a larger supply of nutriment than the others, he must give us some other hypothesis. The case is obviously not parallel to that of the wasps, where the larger insects are queens, the larger *Rhipiphori* differing only in size. So much has this difficulty been felt, that I have seen it somewhere advanced that the larger specimens are always females—making the case parallel with that of the wasps themselves, which Mr. Murray has proved not to be the case. Why, if difference of feeding can produce the result, Mr. Smith should be asserted to be carrying his argument to the extreme in supposing that the *mere* difference between eating a worker-grub and a queen-grub is sufficient to account for the greater dimensions of the one in the queen's cell over the one in the worker's cell, I cannot at all understand. A queen-grub must bear as a meal much the same relation to a worker-grub that the pabulum offered by the wasps to a *Rhipiphorus*-larva, on the supposition that it is a queen-grub because it is in a queen-cell, does to that they would offer to it in a worker-cell, where they must suppose it to be a worker-grub.

As to the difficulties which Mr. Murray finds in the *Rhipiphorus* beginning its repast at the head of its victim, he falls again into the error of supposing that Mr. Smith postulates that the larva of *Rhipiphorus* should perambulate in search of pabulum: this, however, only explains a part of his difficulty, as Mr. Stone's observations and the requirements of the theory that I accept from Mr. Denison show that the *Rhipiphorus*-grub really does begin his attack at or near the head. Here I cannot help suggesting, in parenthesis, somewhat mischievously perhaps, for Mr. Smith's consideration, that if the egg lies dormant during the feeding of the wasp-grub, it must remain so at the bottom of the cell; and then, of course, to the confusion of all parties, the attack of *Rhipiphorus* would "begin at the tail."

Mr. Murray clearly believes that he has here made a strong point. He assumes, with apparently logical accuracy, that if the *Rhipiphorus* begins to devour its victim at the head, it necessarily last eats the tail, and must thus, when it has completed its meal, have its head where its victim's tail was. Part of this error arises, as I have said above, from the supposition that the larva crawls about above the cells in search of a victim—a supposition that no one will object to my dismissing as untrue. But were it true, it would not alter my position that the wasp-grub can be easily (and is) attacked first near its head, yet the parasite assume the proper position in the cell. Let it be clearly understood that the wasp-larva is not to be eaten downwards, segment by segment, as though it were a carrot. It is doubtless eaten just as the larva of *Odynerus spinipes* is by that of *Chrysis bidentata*, viz. its juices sucked out, *at first* partially, of course, leaving it flaccid, so that both larvæ might easily be arranged side by side in the cell, the tail sucker of the victim now probably relaxing its hold of the cell-wall; *afterwards* more thoroughly; and, if the parallel holds good, the victim is reduced to very small dimensions indeed before any thing like eating takes place. I have often seen a larva of *Odynerus spinipes* reduced to very small bulk without any trace of even a microscopic opening in the skin being discoverable. In this way there is no difficulty in understanding how the *Rhipiphorus*-larva is found, when full-fed, with its head to the mouth of the cell. It shows also how the remains (corneous head) of the victim would be beside the head, if not in the jaws, of its devourer, and, it being remembered that the mouth of the cell is downwards, might remain there after the *Rhipiphorus* had assumed the pupal state. But that a Coleopterous pupa should hold any thing in its jaws, whether previously held in the jaws of the larva or not, I can only, with Mr. Murray, regard as impossible; and if Mr. Stone means this, he has clearly committed some error. He uses the phrase "retain in their grasp," which, with perhaps a little forcing, may be supposed to mean the larval grasp, *i. e.* the grasp of the now cast larva-skin. Or we may suppose that the remains of the wasp lying at the top of the cell fell, on its inversion for examination, between the pupa and the wall of the cell, looking just as if held there by the pupa.

I must leave Mr. Smith to deal with the way in which Mr. Murray explains away Mr. Stone's observations, only observing that, in my opinion, if Mr. Stone committed half the errors imputed to him by Mr. Murray, he must henceforth be regarded as the most inaccurate observer on record.

It remains to consider the new facts brought forward by Mr. Murray, and which appear to have first led him to adopt the guest-theory of the life-history of *Rhipiphorus*. These are the three instances in which he found a pupa of *Rhipiphorus* and one of the wasp in the same cell. These are somewhat difficult to explain on either hypothesis, but they seem to me to be much less explicable on the guest-theory than on the parasitic. Mr. Murray finds it very difficult to imagine a wasp-larva turning round in its cell; and, though I have not found wasp-larvæ such completely helpless sacks as he appears to regard them, I agree that for a full-grown larva to turn round in its cell would be simply impossible. Yet, on the guest-theory, this must have occurred in two out of the three instances he mentions. And how the wasps could possibly feed the larva at the bottom of the cell, when the upper one was well grown, I cannot conceive. Mr. Murray has truly remarked that a full-fed wasp-larva, and equally therefore one of *Rhipiphorus*, completely fills the cell it occupies. Now, in the three cases in question, if the larvæ were fed by the wasps, why did one or the other not grow to its proper size, so as to fill the cell, and eject its companion? or why did one not eat the other?—an occurrence of which he elsewhere admits the probability, should a chance occur, which, on the guest-theory, must be but rarely.

On the parasitic theory, we have only to suppose that, for some accidental reason, of which several might easily be imagined, the *Rhipiphorus*-larva ceased to feed before it had drained the juices of its victim to the point of death; the wasp-larva, being at a stage of its existence when it no longer eats, does not, of course, avenge itself. The struggles of the wasp-larva in these uneasy circumstances, and its semiflaccid condition, would easily account for, and render possible, its change of position in the two instances in which that had occurred.

The difficulties which have surrounded the elucidation of the life-history of *Rhipiphorus* may all, I think, be traced to the very short interval that elapses between the laying of the egg and the arrival of the insect at the pupal state. They appear to assume the pupal state almost as soon as the surrounding wasp-grubs; yet the eggs were only laid when these latter were beginning to spin. This allows a very brief period during which they must be found, if these stages are to be observed. Mr. Murray has failed to do so, probably because he did not examine the nests until such a period had elapsed after the nests were taken. I also failed, because, when my opportunities were most abundant, I did not know what to look for. As a similar instance among the *Chrysides*, I may mention the egg of *Chrysis neglecta*, which I have never been able to find. I find young larvæ only, and have satisfied myself that the egg-state does not last as much as twenty-four hours. In the instance I have mentioned above of *Chrysis ignita*, the egg-state cannot have lasted so long.

XX.—*Concluding Observations on the Parasitism of* Rhipiphorus paradoxus. By Frederick Smith, Assistant in the Zoological Department of the British Museum.

With some degree of hesitation, I venture to reassert my belief in the views I put forth in reply to Mr. Murray's first paper on the relations between wasps and *Rhipiphori*. I have some fear of being considered dogmatic, and of not duly weighing the arguments offered to my notice by my friend Mr. Andrew Murray. I must, however, confess myself to be unconverted by his arguments, and unable to arrive at the same conclusions that he does when commenting upon the various phenomena which were presented to him when examining the comb of a wasps' nest. It will perhaps be a matter of astonishment that he has failed in his endeavour to bring me round; and it is equally surprising, but at the same time consolatory, to find Mr. Murray expressing the opinion that, should a larva of *Rhipiphorus* "fall upon a larva of the wasp, of course there is nothing to be surprised at in its eating it." In this instance, at least, we most cordially agree.

I will endeavour fairly, and I hope without bias, to answer the numerous questions offered for solution. I readily agree, then, in the instance in which Miss Ormerod observed two eggs in the same cell, one at the bottom, the other attached a little way within, that in all probability one was the egg of the wasp, the other that of the parasite; but I do not consider this to be necessarily so: I have myself found two, and, I believe, even as many as three, eggs in a cell, in autumnal nests—that is, at that period of the season when the nest is crowded with the three sexes; and I am quite sure that such nests contained no *Rhipiphori*. I never had the good fortune to find a nest infested by the parasite.

Mr. Murray thinks it likely that I can inform him how the larva of the wasp comes out of the egg-shell. This term is scarcely applicable to the eggs either of wasps or bees: shell there is none; and the thin skin in which the contents are enclosed never appears to be cast off by the larva. At one end I have first observed, in the process of development, the gradual formation of a head, while the rest of the envelope I have believed to become the skin of the larva itself. Whether I am right in this or not, future investigation may decide; but I know that the late Mr. Newport, at one time, was of the same opinion.

The first question I am asked to reply to is one that I am not prepared to answer; but whether the larva of the wasp is fed, after being hatched, before it reaches the bottom of the cell, or not, in no way affects the main question. But this question is put in juxtaposition with that of "How about the young *Rhipiphorus*-larva? is that fed too?" Now the inference is obvious—the egg of the wasp and that of the parasite are hatched at the same time. Mr. Stone has told us that in the instance in which he observed the larva of *Rhipiphorus* feeding upon that of the wasp, it was of minute size (that is, recently hatched); and the wasp-larva at that time was full grown. A question follows as to what the larva of the parasite is like. Mr. Stone has given a description of the larva amply sufficient to distinguish it from that of the wasp: he says it is "more deeply furrowed than any larva with which I am acquainted;" it has also "a longitudinal furrow down the back." To this I may add, as I have a larva before me, that it is divided into twelve segments, the apical one having an anal tubercle or style: I include the head in this number; and therefore, if the anal tubercle were counted as a separate segment, it would increase the number to thirteen—

the normal number. It is also furnished with six pairs of spiracles.

Mr. Murray says the description is imperfect, since it is not stated whether the larva has feet or not—" a not unimportant point when the question is whether the larva passes a nearly motionless life in one cell, or a roving one." But there is no such question before us. It feeds upon a single larva in a closed cell, we are informed; there is no travelling about " like a Blondin," neither is there any chance of its being " gobbled up by the big wasp-grub."

It is stated that " we all know (that is, all entomologists know) how soon a larva freshly excluded from the egg shrivels up if its food is not at its mouth the moment it comes out." Now Mr. Murray does not appear to be aware that some parasitic larvæ live for days, nay, even for weeks, until they are conveyed to, or by chance find, the nourishment suitable for their sustenance. The late Mr. George Newport, in his paper on the oil-beetle, has recorded the fact of larvæ living without food for a considerable length of time. He writes, " I saw most of the larvæ leave the egg as early as five o'clock in the morning. They were confined in a tin box for several days; after remaining ten or eleven days, many of them crept beneath the lid." He also mentions other larvæ that he kept nine days, but which were perfectly healthy and active, although they had not taken any nourishment. I have also kept *Meloë*-larvæ for a fortnight in a perfectly active condition without food; also larvæ of *Melittobia*, a bee-parasite: the larvæ of *Monodontomerus*, a parasite upon *Anthophora*, can exist for days without food; and I will just refer to one other parasitic larva, that of *Stylops*: these, when hatched, may be observed perfectly active days after their extrusion from the egg, without nourishment.

I am asked if I " think that a meal of one animal can suffice to nourish another into as great dimensions as the animal eaten." I reply, first, that in the case before us the animals are not of the same dimensions; both are before me, and I see in the wasp a much more bulky insect than the *Rhipiphorus*. I am comparing a worker wasp with its parasite bred from a worker-cell; I have also a pupa from a cell of the queen wasp, and I challenge Mr. Murray to produce a specimen of a *Rhipiphorus* as large as a queen wasp. What will Mr. Murray say when he compares the parasite of *Anthophora* (*Meloë*) with the bee itself? and yet its larva is said to feed upon the larva of the bee; some authors suppose it to feed upon the food stored up by the bee. Now it is clear that *Meloë*, an insect full twice the size of *Anthophora*, is nourished upon the same amount of food necessary for the bee, or it is nourished upon its larva. "If we look," Mr. Murray observes, "at the little black deposit of digested débris at the bottom of the wasps' cells, we find fragments indicating the consumption of hundreds of insects not much smaller than themselves." This statement is intended to prove the impossibility of *Rhipiphorus* being nourished upon a single wasp-grub. In my opinion the fragments are merely fragments of portions of insects with which the wasp-larva had been supplied; these fragments are no proofs of the wasps having eaten entire insects. A wasp frequently carries off a large blowfly; but what proof is there existing to show that the entire fly becomes the food of a single larva? I imagine such an inference will scarcely be accepted as sufficient evidence to overthrow the accumulation of facts recorded by a naturalist who is no longer living to support his own opinions.

It is assumed that Mr. Stone made his observations on a larva situated in the middle of a comb, or at any rate surrounded by other cells containing larvæ, and that, having found that which he had searched for during several years, he took so little precaution in making his observations, that, having seen the parasite feeding, he went away, returned, looked into another cell in which was a mature larva of the parasite, and in this manner was led to record a series of mistaken observations. I will venture to affirm that, had Mr. Murray been acquainted with Mr. Stone's methodical way of making his observations, he would have felt assured of such a mistake being impossible. The larvæ of *Rhipiphori*, it is affirmed, should always be found in sealed cells, if one wasp-grub is sufficient to nourish them. Certainly, so they should; and be it observed that Mr. Stone, on taking out the wasps' nest, proceeded to open the "closed cells." He afterwards took thirteen nests which each contained *Rhipiphori*, either in the larva-, pupa-, or perfect state; he afterwards records that, on opening some "closed-up cells" appropriated to queens, he found one larva and one pupa. I contend that the fair inference to be drawn from this is that all were in closed cells. Now it is quite possible that the larvæ (he does not say what proportion these bore to the pupæ and perfect insects) were all full-grown, having fed upon the grubs of the wasp: of course they would then be solitary in the cells. Mr. Murray asks what the mass of larvæ were doing in cells by themselves. There is no mass spoken of by Mr. Stone. And will Mr. Murray venture to affirm that, as soon as a larva is full-fed, it immediately assumes the pupa state? If he will, he will do so in the face of an overwhelming mass of evidence to the contrary. I affirm, from actual observation, that they do not.

It is stated that, if Mr. Stone's observation is correct, we should never see any half-grown larvæ; there should be no medium between a minute one and a full-grown one, except during the forty-eight hours at which it is at its meal. I quite agree to the cases of exception. Mr. Stone has recorded the instance in which he saw a "minute" one, and also one which he calls "small:" the latter is in my possession; its length is 3 lines, that of the wasp to which it is attached is 5½ lines. Mr. Murray has seen these larvæ, and he states in his paper that "both are well grown."

With regard to the difference of size in perfect examples of *Rhipiphorus*, I find the difference to be exactly parallel to that which is observable in worker wasps. I have six examples in my collection; they differ in size as follows:—9, 10, 11, 11½ millimetres. Worker wasps vary in size from 5½ lines to 7 lines.

It is stated that the only cases of alleged attacks upon wasp-larvæ are those recorded by Mr. Stone: this is not strictly correct, since I have, in my former paper, quoted from the Rev. E. Bigg's paper on wasps the statement that Mr. Denison, in several instances, observed them in all stages of their growth. The *Rhipiphorus* is called a fly: this, Mr. Curtis observes, is, no doubt, the *Rhipiphorus* which "deposits its egg upon the grub of the wasp at the moment it assumes the pupa; as soon as the egg is hatched, it devours the grub of the wasp entirely, and itself assumes the pupa and imago form in the cells of the wasp."

Admitting that many particulars are here wanting, and which, no doubt, some intelligent entomologist will furnish very shortly, as several are fully bent upon the investigation, still every candid person will allow that the statement bears strongly in favour of the accuracy of Mr. Stone's observations.

When Mr. Stone opened the closed cell in which he found a wasp-larva attacked by a minute *Rhipiphorus*-larva, Mr. Murray thinks he should have found a wasp-pupa; why, is not stated; but it is assumed, no doubt, that immediately the wasp-grub has spun the silken cap over the mouth of the cell, it momentarily assumes the pupa state. If Mr. Murray has not, I have, and so have hundreds of persons besides, extracted wasp-grubs from closed cells for baits when angling.

It is assumed that possibly Mr. Stone picked a minute larva of *Rhipiphorus* out of a cell and dropped it upon the wasp-larva. "If it fell upon a larva," Mr. Murray observes, "of course there is nothing to be surprised at in its eating it, as the wasp-grub would have done with it if it had got the first chance." The cells opened by Mr. Stone contained full-grown larvæ of wasps; they had therefore ceased to feed. It is also stated to be "against all rules of probability that the cell should have been opened at that precise juncture of time at which it began its attack." Now I would remind every entomologist that the fact recorded by Mr. Stone offers an explanation, because, although many persons have repeatedly found *Rhipiphorus* in wasps' nests, only two record their having observed the beetle-larva preying upon that of the wasp. And why have they not? The parasitic larva becomes full-fed in forty-eight hours: therefore although full-fed larva have been found, immature ones have seldom been met with.

The parasitic larva is always spoken of as having eaten the wasp-larva, as if it had fed upon some solid substance. If this eating were understood as extracting the soft and semifluid contents, it would be more correct. Mr. Stone made no "ludicrous blunder" when he stated that it inserted its head beneath that of its victim. I see no difficulty in its extracting the entire contents of the larval skin in that position; and I must protest against the supposition that Mr. Stone did not know the head from the tail of a wasp-larva.

I shall only, in conclusion, offer a few remarks upon a passage in which the statement requires both correction and refutation. After alluding to the instance in which Mr. Stone discovered a small larva of *Rhipiphorus* firmly attached to its victim, both being dead, the nest having been taken by destroying the wasps by means of gas-tar, and both having become partially dried, so that, when immersed in spirit, they did not separate, Mr. Murray tells us that he considers this a case of double occupation, similar to those which have come under his notice, and the attachment to be probably nothing more than what may be seen in every bottle of insects sent home from abroad or collected at home, the insects having, in their mortal agony, seized the nearest object with their mandibles. Now I will ask what analogy is there between the perfect insects collected and thrown into a bottle and larvæ so immersed? Have larvæ been observed to attach themselves in spirit? Mr. Stone's larvæ were found attached in the cell, dead and partially dried—in fact, just in the position in which they were when suddenly killed by the gas-tar.

In a postscript, Mr. Murray admits having seen the specimens I have just alluded to, and finds them "presenting *almost exactly* the same appearance as some specimens in the South-Kensington Museum; but he cannot say whether they are merely in juxtaposition or if one has its jaws fastened on the other; but both are *well grown.*" The latter observation is not quite correct, and it is calculated to throw some doubt upon the accuracy of Mr. Stone's words, which are, "I was fortunate in discovering a *small larva* attached to its victim." The size of the parasitic larva is 3 lines, that of the wasp $5\frac{1}{2}$; they have been in spirit since 1865, and were partially dried at the time they were immersed, so that the exact relative size cannot be ascertained; but the present difference between them justifies Mr. Stone in calling the parasitic larva small. I have carefully examined them, and am satisfied of the *Rhiphorus*-larva being attached to the wasp-larva just below the head; there is no attachment of the rest of its body: I have separated the bodies, and proved it.

The last paragraph of the postscript is entirely suppositional. Mr. Murray has not shown me any of his specimens: I have seen no pupæ with the cast skin sticking to their tail; and if I had, I should only have seen the reverse of what Mr. Stone records, who describes the larva of *Rhipiphorus* as having its "mouth buried in the body of the wasp-larva just below the head."

Let it be distinctly understood that I admit that it is possible, but *highly improbable*, that Mr. Stone has recorded mistaken observations.

From actual observation I know nothing of the subject. I was never so fortunate as to find a nest infested by the parasite; but for some years I had the enjoyment of a close correspondence with Mr. Stone, and I know him to have been a most accurate and careful observer; and, until actual observation prove his statements to be fallacious, I shall have a firm belief in their truth.

XXI.—*Häckel on the Relationship of the Sponges to the Corals.* By Wm. S. Kent, F.Z.S., F.R.M.S., of the Geological Department, British Museum.

Science does and always must acknowledge herself indebted to those who unveil the mysteries of nature by demonstrating to us the singleness of purpose and the uniformity of the laws which have been in operation from "the beginning." In the last two numbers of the 'Annals,' Mr. Dallas favours us with a translation of Ernst Häckel's article, published in the 'Jenaische Zeitschrift,' "On the Organization of the Sponges, and their Relationship to the Corals."

Admitting that once, far away back beyond the limits of the Silurian epoch, there in all probability did exist a something equivalent to Häckel's hypothetical *Protascus*, and from which the existing stock of sponges and corals has probably been evolved (and it must not be forgotten, by the way, that the latter and by far the more highly organized of the two stocks had attained the very zenith of its development long before the epoch referred to had commenced its decline), it nevertheless forces itself upon one's mind that the evidence he brings forward in support of the supposed intimate relationship of the two groups as they *now* exist is based rather on affinities of analogy than of homology.

By the corals, as a matter of course, and in concurrence with Häckel's own rendering, is understood that section of the Cœlenterata known as the Zoantharia or Anthozoa, which forms them. Häckel, after some time spent on the examination of the calcareous sponges ("Calcispongiæ"), essays to demonstrate that the whole group of the sponges is far more closely allied to that of the Zoantharia than most modern naturalists have been inclined to allow, and that this particular section contains an existing form, *Prosycum* (Häck.), which, derived from the hypothetical *Protascus*, may be regarded as the stock-form from which all the other Calcispongiæ have been evolved.

This last hypothesis seems possible, and even highly probable; and we must not omit here to pay a willing tribute of admiration to the valuable contribution to science and the vast amount of original information Ernst Häckel's recent researches have been productive of, and this relative to a group of the Spongiadæ which up to the present time had been looked upon as very sparingly represented, but which his zealous investigations have resulted in augmenting to no fewer than 42 genera and 132 species. At the same time, however, the arguments he advances in seeking to demonstrate the close relationship of the Spongiadæ and Actinaria seem scarcely sufficient to warrant his proposed amalgamation of the two groups as sections of the same subkingdom—many of these arguments, moreover, being purely theoretical, and entirely inconsistent with the facts which have been elucidated by the investigations of other experienced naturalists.

In accordance with the opinion in the first place conceived by Leuckart, Häckel looks upon an aggregation of coral-animals, or polyp-colony, as the equivalent of a sponge-mass with its large "water-canals" opening outwardly; he, however, carries his supposition of existing homologies between the two organisms to a far greater extent than the first-named writer ever attempted to attain to.

Maintaining, in confirmation of the theory propounded by

Oscar Schmidt, that every part of the sponge-body which possesses an excurrent orifice (osculum) is to be regarded as a distinct individual, he considers each single sponge-body bearing only a single osculum, and which he denominates an individual or person, to be the equivalent of an *Actinia* or any other such solitary coral-animal—and this not only as far as their distinct individuality is concerned, but also in regard to their respective morphological characters.

The accompanying diagrammatic illustrations of sections of

Fig. 1.

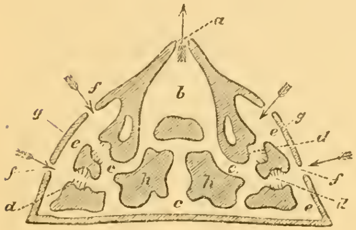


Fig. 2.

Fig. 1. Hypothetical vertical section of a *Spongilla* having a single excurrent orifice: *a*, excurrent orifice; *b*, central excurrent cavity; *c*, interstitial canal-system; *d*, ciliated chambers; *e*, intermarginal cavities; *f*, incurrent apertures; *g*, dermal membrane; *h*, deeper substance of the sponge*.

Fig. 2. Transverse section of a similar sponge; the lettering corresponds with that made use of in the last figure. It is necessary to observe that radiate symmetry has been greatly exaggerated in these two figures to adapt them as far as possible for comparison with figs. 3 & 4.

Fig. 3.

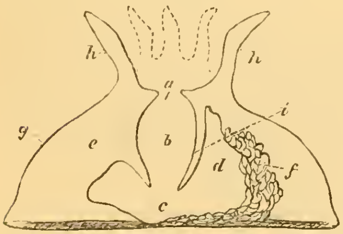


Fig. 4.

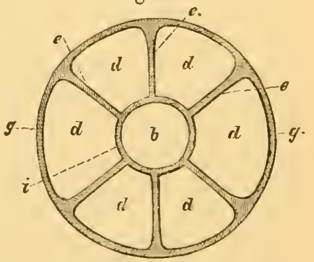


Fig. 3. Ideal vertical section of an *Actinia*: *a*, the mouth; *b*, alimentary canal or cavity; *c*, common digestive cavity; *d*, intermesenteric chamber, or portion of perivisceral cavity; *e*, a mesentery; *f*, reproductive organ; *g*, body-wall; *h*, tentacles; *i*, wall of alimentary canal.

Fig. 4. Transverse section of the same, the lettering in correspondence with the last.

* Figs. 1 & 3 are modified from illustrations given in Prof. Huxley's 'Introduction to the Classification of Animals.'

an ideal sponge-body (*Spongilla*), bearing a single osculum, and of an ordinary *Actinia* will present to the reader such analogies or homologies of form and structure as may appear to exist, and will aid materially in the institution of comparisons.

These two forms may be described as being so far analogous that, in longitudinal section, they both present the same conical outline, that the summit of each cone is provided with an aperture, *a*, and that in both instances this aperture communicates with an inferior cavity, *b*, which leads again into ulterior ramifications marked *c*, *d*; beyond this, however, analogy fails to assist us; and an inquiry into the functional properties of these regions demonstrates them to be the very opposite to homologous.

The researches of Huxley, Grant, Carter, Bowerbank, and other naturalists have long since demonstrated the essential characters of a sponge-body to be the following:—

In addition to the large apertures, or aperture, as at fig. 1 *a*, the dermal membrane, *g*, is perforated by an indefinite number of smaller ones (pores), marked *f*; these communicate (by a series of canals, of various forms and dimensions, fig. 1, *e*, *d*, *c*, which traverse the deeper layers of the sponge-body) with the osculum, *a*, by means of the central excurrent cavity, *b*. A flow of water, when the sponge-mass is in a healthy condition, is constantly setting in at the pores, drawn by the ciliary action progressing in the chambers marked *d*, and, having traversed the interstitial canals and cavities in the body-mass, debouches into the central excurrent cavity *b*, and is finally expelled from the organism at the osculum or excurrent aperture, *a**.

These currents, according to the observations of Dr. Bowerbank, are exercised in two different modes—the one being vigorous and of comparatively short duration, when the animal is feeding, and the other very gentle and persistent, and being evidently subservient to purposes of respiration only; and the last-named author, whose extensive experience with this class of animals is so eminently conspicuous in his excellent and exhaustive 'Monograph of the British Spongiadæ,' states that in no single species which he has had the opportunity of examining in a fresh and vigorous condition has he failed to detect these currents.

The same writer also ably proves that the imbibition of the surrounding fluid during the energetic action of the sponge is

* Separate ciliated chambers cannot be said to be essential to the fully developed sponge-organism, the ciliated cells in many forms being equally distributed throughout the interstitial canal-system.

equivalent to the operation of feeding in the higher classes of animals. By experiments with finely comminuted indigo placed in the water at such times, he observes that the molecules are rapidly drawn into the pores; and having undergone digestion in the sarcode lining of the interior of the sponge, the effete matter is ejected through the osculum. The fæcal matters discharged by the oscula, he adds, exhibit all the characteristics of having undergone a complete digestion; and whatever may have been the condition of the molecules of organized matter on entering the sponge, their appearance after their ejection is always that of a state of thorough exhaustion and collapse.

The foregoing facts amply demonstrate that a fully organized sponge is entirely dependent on ciliary action for its nourishment, and that the nutritious matters on which it subsists are brought to it through numerous apertures, and through the medium of a more or less complex canal-system.

Referring, now, to fig. 3, as illustrative of our second class, the Zoantharia, it will be easy to ascertain the value of the analogies of structure already noticed.

The terminal orifice, *a*, is here the sole aperture essential to the well-being of the animal. It constitutes a true buccal orifice or mouth, through which all nutrient matters have to pass to the common digestive cavity with its prolongations, *c*, *d*, through the medium of the alimentary cavity or canal, *b*, and through which again, after undergoing digestion, all effete matters are finally ejected.

This alimentary system is something totally different from what has just been shown to obtain in *Spongilla*; and comparison of the means by which the food is here brought into relationship with the digestive cavity reveals at once how essentially and insuperably the two classes are isolated from each other now, however close might have been their bond of affinity in by-gone epochs. In the sponge, ciliary action has been demonstrated to be the highest force exerted for securing the necessary sustenance for its body-mass. This force exerted, as I shall presently show there is great reason for believing, is a purely mechanical and involuntary one; but any one who has watched an *Actinia* take its food must have recognized that it achieves its end by the exercise of a force incomparably higher than that produced by the action of cilia, its prey, often living creatures almost equalling itself in dimensions, being seized and forcibly dragged, by aid of its tentacles and its prehensile, and frequently protrusible, lips which bound the aperture of the mouth, into its alimentary canal, from which it is passed on to the common digestive cavity.

The shallowness of Leuckart's hypothesis, in a measure supported by Häckel, of a polyp-colony with imperfectly separated individuals, devoid of tentacles, stomachal sac (alimentary canal), and internal septa, being the image of a sponge with its large "water-canals" (oscula) opening inwardly, here becomes most evident. Such an organism could not exist; for a polyp or polyp-colony bereft of its tentacles, and as a matter of course of its prehensile lips, though it might be hacked into somewhat the outward resemblance of a sponge, would be entirely deprived of its means of subsistence, and would, sooner or later, inevitably perish.

The few facts already adduced suffice to show that the two organisms are most distinctly and widely separated from each other. There are numerous other points, however, which can be best indicated in following up Häckel's line of reasoning, that demonstrate still further that the sponges cannot be consistently incorporated with the Cœlenterata. In the first place, Häckel endeavours to show that the peculiar canal-system of the sponges is not a perfectly specific nutritive apparatus, such as occurs in no other class of animals, notwithstanding that he at the same time admits that all recent zoologists who have gained most credit for their systematic investigations of the class consider it to be so.

In opposition to this generally received opinion, he starts with the proposition that "The sponges are most nearly allied to the corals of all organisms. Certain sponges differ from certain corals only by a less degree of histological differentiation, and especially by the want of urticating organs. The most essential peculiarity of the organization of the sponges is their nutritive canal-system, which is homologous with and analogous to the so-called gastrovascular apparatus of the Cœlenterata."

This latter portion of his proposition is certainly somewhat startling, after consideration of the facts which have been already stated. Before proceeding to bring forward his evidence in support of his rather astounding proposition, he next proceeds, somewhat prematurely, to prepare for them a snug place where they may be interpolated among, and as representatives of, the true Cœlenterata.

Such an end he achieves by entirely upsetting the clear limits by which this subkingdom is marked out and subdivided, with the mutual consent of the most eminent naturalists of the day. There is scarcely any other subkingdom which is more clearly defined, under its present limitations, than the Cœlenterata, or one that is further subdivided into two more clear and distinct sections than that of the Actinozoa and Hydrozoa.

Ignoring this system, substantiated as it is by well-marked structural characteristics, he proposes to substitute in its place one primarily dependent on mere external resemblances, thus leading us back to the same stage we had arrived at exactly one century ago.

Häckel's proposed system of redistributing the Cœlenterata is, in the first place, to separate it into two sections, which he distinguishes as bush-animals (Thamnoda) and sea-jellies Medusæ). The first of these he further separates into the two classes of the sponges (Spongiæ) and corals (Corallia), and the second into that of the umbrella-jellies (Hydromedusæ) and comb-jellies (Ctenophoræ). In which of these classes the Hydroid Zoophytes (comprising the Hydridæ, Corynidæ, and Sertularidæ) are to be included, there is no indication whatever, and it is scarcely to be inferred that he would incorporate them with the coral-forming Actinozoa.

Having viewed Häckel's elevation of the Spongiadæ to the rank of true Cœlenterates, we next search for the evidence promised in support of the very sweeping change he seeks to effect.

In the first place he states that the actual homology which he presumes to exist between the sponges and corals has hitherto been, for the most part, overlooked in consequence of the investigations of zoologists being almost entirely confined to the two common forms *Spongilla* and *Euspongia*, which he considers to differ considerably from the original and typical structure of the entire class; and he says that the legion of the Calcispongiæ is much better calculated to shed a light upon their typical organization and their true affinities. One sponge, however, belonging to his chosen legion (*Grantia compressa*, indigenous to our coasts) has formed the subject of particular investigation by Dr. Bowerbank and other naturalists; and though the different regions are modified in this species to a considerable extent, the same type of structure is essentially predominant. The central excurrent cavity, fig. 1 *b*, of *Spongilla*, for instance, is in *Grantia* developed to a marvellous extent, and this at the expense of the complex interstitial canal-system, which is almost entirely rudimentary. The functions of nutrition, however, are carried out upon precisely the same principle, the pabulum being received into the body-mass at the pores, and, after undergoing digestion, being excreted at the oscula, as in other Spongiadæ; and, in fact, this species is the form in which the ciliary action and the characteristic incurrent and excurrent flow of the water before described has been viewed with greater facility than in almost any other.

The canal-system, with the circulatory and nutritive functions dependent upon it, has, then, been demonstrated to obtain in both the calcareous and siliceous sponges, as represented by *Grantia* and *Spongilla*. Nor is evidence wanting to show that the same arrangement holds good with the third order, or *Keratosa*.

Dr. Grant, in his interesting description of the excurrent action of the sponges in general, remarks upon *Spongia panicea* as exhibiting the strongest current he ever witnessed; and, to use his own words, he says, "Two entire round portions of this sponge were placed together in a glass of sea-water, with their orifices (oscula) opposite to each other, at the distance of two inches; they appeared to the naked eye like two living batteries, and soon covered each other with feculent matter."

The whole weight of Häckel's argument in favour of the sponges being incorporated with the corals rests upon his insisting on designating the excretory orifice of the sponge its mouth or incurrent orifice, and in regarding the interstitial canal-system as homologous with the cœlenteric-vascular system of the corals. Reflection alone, in connexion with the foregoing facts, is sufficient to show his first assumption to be both inconsistent and untenable; and it is likewise a matter of no great difficulty to demonstrate that his latter assumption of homology of structure is entirely hypothetical.

Now this cœlenteric-vascular or gastrovascular system of the Actinaria, what is it? As may be shown, something far simpler than the lengthy terminology made use of by Häckel would seem to imply.

A transverse section of any Actinozoon presents us with the appearance shown at fig. 4—a double tube, the inner one of which, *b*, is the alimentary canal, and is brought into relationship by means of radiating connexions, the mesenteries, *e*, with the outer one, or body-wall of the animal, *g*. This section is supposed to be taken about halfway down in the region marked *b* in fig. 3. The six spaces marked *d*, in fig. 4, are the intermesenteric chambers; and though separated from each other by the mesenteries at this point of section, they communicate with each other freely lower down by means of the common digestive cavity, fig. 3, *c*, of which, in fact, they are simply prolongations. The region of the mesenteries, surrounding as it does the alimentary cavity or canal, is generally known as the perivisceral cavity; into this all the nutrient matters are passed, and undergo digestion, after having traversed the alimentary canal of the animal; and this is what constitutes the cœlenteric-vascular or gastrovascular system of Häckel. Such is the essential and symmetrical type of structure which obtains throughout the Actinozoa; we now turn to the sponge tribe to ascertain what its representative shares in common with it.

Fig. 2 is supposed to represent a transverse section of a highly developed sponge with a single excurrent aperture, as at fig. 1, taken through a similar region as the section at fig. 4.

A glance is sufficient to show us at once that we have here something entirely irreconcilable with what obtains in the corresponding section of an Actinozoon, and very few words will suffice to indicate how sharply defined and "thoroughgoing" are the points of distinction.

The most striking of all the phenomena presented are, perhaps, the perforations in the body-wall, *f*, *f*, *f* (assuming for the nonce that this sponge-body is a distinct individual); these apertures are as essential to the existence of the sponge as the single terminal buccal orifice is to the *Actinia*, and are, in fact, as has been already shown, the channels through which it derives all matters of nutrition. Next we have the interstitial system of canals pervading the whole body-mass, intercommunicating with each other in every direction, and finally debouching in the common excurrent cavity *b*. Can we be said to have here any thing homologous or even analogous to the double tube and symmetrical mesenteric system of the Actinozoon? Häckel endeavours to surmount the difficulty of this peculiar and essential incurrent porous system of the sponge by supposing the cuticular pores in connexion with the somatic cavity occasionally met with in some *Actiniæ* to be its homologue; but these cuticular pores of the sea-anemone are exceptional, and by no means an essential portion of the animal's structure, and much less are they subservient to its functions of nutrition. He presumes, again, that these cuticular pores may be constant, though hitherto unobserved, in all the Actinozoa, and that currents of water, serving respiratory purposes, are constantly passing through them into the general stomachal cavity; and taking this for granted, he, in the next paragraph, asserts, as a matter of positive fact, "that an essential morphological difference does not exist between the nutrient vascular system of the sponges and corals;" that both (solitary individuals) possess a central cavity or stomach, which opens outwards by a single large orifice (the osculum or mouth), from which cavity canals issue in all directions, which traverse the body-wall, and finally open on the surface by the cutaneous pores.

This assertion is built up on a framework of mere hypothesis; and its entire fallacy is proved by the fact that the largest section of the coral-forming Actinozoa, the whole of the Madreporaria imperforata, includes genera, such as *Caryophyllia*, *Flabellum*, *Lophohelia*, *Euphyllia*, *Phyllangia*, and numbers of others, in which the whole body-wall is strengthened by a compact and imperforate theca, which, again, is frequently rendered still more dense by the superposition of an equally compact and imperforate epitheca. A current of water passing through the body-wall into the somatic cavity of these animals would thus be a matter of perfect impossibility; and even if such did constantly exist, the perforations for its admission would be something essentially different from the apertures occupying the same position in the sponge: in the latter they have been proved to be the channels through which the body-mass derives all matters of nutrition, while in the Actinozoa they could, at the outside, be subservient only to the function of respiration; the aperture subservient to nutrition, as already shown, being the terminal buccal orifice or mouth. The very few isolated examples of the Actinozoa, however, in which these cutaneous pores have been found to exist, demonstrate beyond doubt that they cannot be subservient to so important and essential a function as that of respiration.

The next argument brought forward by Häckel appears, at first sight, to be more formidable, though on closer inspection its seeming importance vanishes. In the first place he testifies to having examined sponges whose oscula have permitted the inflow as well as the outflow of water. This condition of affairs, however, appears to have been quite an abnormal one; he cites no single instance in which the inflow of water at the osculum proved constant; and, as I shall hereafter show, this temporary and abnormal condition observed by him can readily be accounted for. The second and, seemingly, the more important part of his argument is his statement that certain sponges exist which possess no cutaneous pores at all. (The advantage his theory derives from this fact, after his assumption that all Actinozoa *do* possess them, is not clearly perceptible.) On inquiry into what sponges these are, however, we find that they consist of only two *microscopically* small forms, for one of which he proposes the name of *Prosycum*. Now the very fact of their microscopic minuteness entirely neutralizes the force of his argument, the small number of amœboid particles which must constitute so minute a sponge-mass being necessarily brought into relationship with the surrounding element without the requirement of a complex canal-system; and for the same reason, again, they find sufficient nutriment in the water around them (as with the ordinary fixed Rhizopoda, to which these low sponge-forms seem most closely to approximate) without being dependent on the action of ciliary currents.

Häckel's "ontogenetic" arguments in favour of the close relationship of the sponges to the corals next attract our attention; but whatever "phylogenetic" significance may be attached to them, it is quite sufficient to reply that evidence of affinity may be substantiated on equally strong grounds between the respective classes of the Scolecida, the Annelida, and the Echinodermata, these all originating, in common with the sponges and corals, from free-swimming ciliated larvæ in possession of a simple digestive cavity, opening outwards by a single terminal orifice.

We are now in a position to demonstrate not only that the representatives of the Porifera, or sponge-class, are quite distinct from the Actinaria or Cœlenterate coral-forming animals, but that they belong to a section peculiar in itself, and far less highly organized.

Commencing with the alimentary apparatus. It has been shown that the buccal orifice in the Cœlenterata is single and terminal. In the Spongiadæ, on the contrary, its homologue consists of a multitudinous and indefinite number of apertures which perforate the body-wall of the organism.

In the Cœlenterata this single buccal orifice is also the channel through which all excretory matters are voided. In the Spongiadæ there are distinct apertures, the flues or oscula, set apart for the purpose of carrying off the effete matters.

All Actinaria are provided with tentacles, or, where these are rudimentary, with a prehensile and protrusible buccal orifice, wherewith they sieze and secure their prey. The most highly developed sponges are dependent on the action of ciliary currents for the acquisition of the nutrient matters which support them.

This last diagnosis may, I think, be regarded as one of the highest importance,—the one force (in the case of the Actinaria) being exerted by the free will of the animal, and the other one, we have every reason to believe, being purely involuntary and vegetative. Dr. Bowerbank himself directs attention to the fact that the ciliary action which progresses within the interstitial cavities of the sponge is precisely similar in its nature to what obtains in the ciliated epithelium of the higher vertebrata; this we know to be involuntary: have we any reason for supposing that it assumes a more complex nature in the low-organized animals now under consideration? One objection that will probably be urged, as inconsistent with the theory of the sponges acquiring their nutriment through the agency of involuntary action, is the fact that at different periods the inflow of water through the pores varies much in the strength of its action. This objection, however, is easily overruled when we come to consider that the animal mass possesses such an amount of irritability and contractility in its dermal membrane that it is enabled to reduce the size of the orifices of its incurrent pores to a mere minimum, or, indeed, to close them altogether. This second condition of affairs (that of the partial closing of the pores) is actually certified by Dr. Bowerbank to exist during the less vigorous action of the ciliary currents in *Spongilla*, *Grantia*, and other genera. Now, supposing that this contraction is carried to the utmost, and the incurrent orifices are entirely closed, premising that the ciliary action, which seems to be a fair presumption, is in a constant state of progress, what result should we arrive at? The terminal osculum would alone remain open, and a sluggish current would probably set in at it, as Häckel and his pupil Miklucho testify to having occasionally witnessed; and in support of this proposed interpretation, it is a significant fact that Häckel, in recording the phenomenon of a current setting in at the osculum, makes no mention whatever of one setting out at the pores, which, had they been open, must inevitably have taken place*.

Equal in importance to the wide difference which most evidently exists between the alimentary and nutritive systems of the two classes in question, is that of the histological structure of the body-mass itself.

Häckel contends that the tissues of the sponge are as clearly separable into an ectoderm and an endoderm as are those of the

* A curious demonstration of the involuntary nature of ciliary action was brought before my notice two summers ago. Having for some time kept that interesting and abnormal Polyzoon, *Cristatella mucedo*, alive in a glass receptacle, it at length, from exhaustion of the supply of food or other causes, died, decayed, and underwent disintegration. One day my attention was drawn to the vessel which had contained it by a number of particles of organized matter of various sizes careering about in the water in a most grotesque and extraordinary manner—some propelling themselves straight ahead and simply rotating on their axes, others describing circles, parabolic and spiral curves, and a host of other figures, which even a Senior Wrangler would be puzzled to describe. Forgetting at the moment what had formerly been placed in the vessel, it first suggested itself that these were some peculiar Infusoria or larval conditions of other higher organisms; on specimens being examined with the aid of the microscope, however, the fact was revealed that they were nothing more nor less than fragments of the decomposed tentacles of the once translucent *Cristatella*, propelled through their mazy courses by the still active vibration of the cilia which clothed them. Now the thorough disintegration of these tentacles must have taken place many days, if not weeks, after the death of the animal; and the motion, moreover, continuing vigorously for a number of days after my first observation of the phenomenon, we have here proof direct of the involuntary nature of ciliary action, if, indeed, we are not justified in describing it as simply a phase of the molecular.

Actinaria: such a differentiation, however, is, to say the least of it, carried out to a considerably less degree. There are certain sponges which are invested with a pellicular and somewhat tough dermal membrane; but in the majority of instances and in the most highly organized representatives of the class, such an amount of differentiation is by no means recognizable. The new and very beautiful siliceous sponge *Holtenia Carpenteri*, recently dredged by Prof. Wyville Thomson and Dr. Carpenter in the Shetland seas, is a good example of this type of organization. A fine specimen of this highly interesting form, immersed in spirit, has recently been consigned to the National Collection; but the appearance of the body-substance to the unassisted eye is that of a simple homogeneous mass of sarcode, showing a tendency to fracture in every direction, aggregated upon the dense network of spicula which support it*, something entirely different from the appearance of an Actinarian viewed under similar conditions. This form, moreover, possessing a single very large flue or osculum, would be regarded by Häckel as correlative with a solitary *Actinia*; and the large size of this species (the body of the sponge proper measuring some four inches in both length and diameter, and having a general excurrent aperture of the width of an inch and a half) would be admirably adapted for comparison with some huge *A. crassicornis*; the differences existing between two such similar structures, however, as in the examples of *Spongilla* and an ordinary *Actinia*, have been already so clearly indicated as to render further comparison unnecessary, except, perhaps, that, in the living condition, the firm elastic ectoderm of *crassicornis* would offer a most striking and distinctive feature by the side of the low-organized and glairy sarcodic investiture of *Holtenia*.

While on the subject of the dermal investiture of the sponges, it will not be out of place to remark that in those instances where the dermal membrane attains a comparatively high degree of development, it has been observed, most generally, to possess a peculiarity essentially its own, and one not met with in any Cœlenterate organism. This is its property of being able to separate its individual component particles at any point whatever, and so form the pores, *f*, figs. 1 & 2, for

* It has been suggested to me that the spicular skeletal system of the Spongiadæ seems to indicate their close relationship to the Actinozoa. Siliceous spicula most closely resembling those of the Spongiadæ, however, are of common occurrence in that section of the true Protozoa known as the *Radiolaria*, the great spicule-secreting division of the Actinozoa (the *Alcyonaria*), on the other hand, never being found to possess any thing like an approach to such forms.

the admission of the water into the subjacent intermarginal cavities, *e*; on these becoming closed up, on account of irritation or other causes, apertures reappear, not where the original ones obtained, but at a totally different portion of the membrane. This property is essentially Protozoic. According to Häckel, the only difference in histological structure existing between the Cœlenterata and the Spongiadæ is that the representatives of the former possess nematophores or urticating cells, while those of the latter are entirely devoid of them. It must be admitted that this distinction is of itself a very important one, since it demonstrates that the former possess a much more complex degree of organization. But this is surely not all: Häckel seems to have entirely ignored the fact that the tissues of the Cœlenterata undergo a still further degree of modification, and assume the form of true unstriated muscular tissue; and in some of the higher forms (the Ctenophora) even a nervous system has been discovered.

In the sponges, on the other hand, primitive fibrous or connective tissue is the very highest degree of differentiation which obtains.

Lastly, it may be considered an open question whether a sponge-body can lay claim to the rank of distinct and separate individuality, or whether, as in accordance with the views of the majority of modern writers, it must not be regarded as an aggregation of amœbiform animals building up among themselves a common skeletal support.

This latter interpretation forces itself strongly upon one's mind when we come to consider the nature of the sarcodic substance lining all the interstitial cavities of the sponge, and spreading itself out upon and investing its horny, siliceous, or calcareous skeleton, which sarcode is capable of resolving itself into masses of unequal size and variable form, of separating itself from the parent mass and becoming developed into a perfect sponge, or of uniting with it again, or with any other individual of the same species.

In the same way with the minute sponge-particles lining the passages, each of which is capable of appropriating to itself the molecules of food brought within its reach; so that, to borrow a metaphor from Professor Huxley, when treating on *Spongilla*, "We must not compare the system of apertures and canals to so many mouths and intestines, but the sponge represents a kind of subaqueous city, where the people are arranged about the streets and roads in such a manner that each can appropriate his food from the water as it passes along."

Viewed in this light, the affinity of the Spongiadæ to the Protozoa rather than to the Cœlenterata makes itself eminently conspicuous. Compared with the latter subkingdom, it is evident that the sponges possess a very much lower degree of organization and an essentially different type of structure, while at the same time their occasionally differentiated and consolidated dermal membrane, their development, in some instances, of primitive fibrous tissue, and their complex interstitial canal-system entitle them, in a natural and morphological system of classification, to be ranked as the highest representatives of the Protozoa.

XXII.—*Descriptions of some new Species of Birds from Southern Asia.* By ARTHUR, Viscount WALDEN, P.Z.S. &c.

Sitta neglecta, n. sp.

Above pale slate-colour. Stripe from nostrils, through the eyes to nape, black. Lores, supercilium, cheeks, chin, and base of primaries white. Throat tawny white. Breast pale rufous, deepening into dark rusty on remainder of lower surface. Under tail-coverts white, with narrow rusty edgings. Middle rectrices uniform slate-colour. Wing 3 inches; bill $\frac{4}{8}$ inch.

Three examples of this Nuthatch were obtained from the Karen Hills of the Toungoo district, Burma. It differs from its nearest ally, *S. himalayensis*, J. & S., by its much stouter and longer bill, by the deep ferruginous tint of the under surface, and by the absence of a white spot on the basal half of the middle rectrices.

Passer assimilis, n. sp.

Resembles *P. cinnamomeus*, Gould, but differs by being smaller, by having a slenderer and smaller bill, and by having the cheeks and sides of the neck pure white, and the breast, flanks, and ventral region ashy grey. Wing $2\frac{5}{8}$ inches; tail $1\frac{6}{8}$, or nearly half an inch shorter than in *P. cinnamomeus*.

From Toungoo.

Glaucomyias sordida, n. sp.

General colour ashy grey, washed with a faint tinge of blue or greenish blue. Forehead, supercilium, chin, and lesser shoulder-coverts deep pure blue. Under shoulder-coverts, axillaries, vent, and under tail-coverts white. Tail brown, with a dingy gloss of dark green. Bill, legs, and claws black. Lores black. Wing nearly 3 inches; tail $2\frac{4}{8}$; tarsus $\frac{5}{8}$; fourth and fifth quills equal; third nearly as long; second still shorter than third; first half the length of second. Bill lengthened and much hooked.

Four examples of this very distinct species were sent to me from Ceylon. I am not certain that it should not be classed as a *Cyornis*, near to *C. unicolor*, Blyth. At first sight it resembles an immature *G. melanops*, Vigors.

Prinia albogularis, n. sp.

Upper surface, cheeks, and sides of neck ashy brown, faintly tinged with olive. Quills and upper surface of tail brown. Quills edged externally with rufous. Chin, throat, ventral region, and under tail-coverts pure white. Breast and flanks ashy grey, the grey breast contrasting strongly with the white throat. Tail consisting of ten feathers, each of which, except the middle pair, is tipped with white, which forms an edging to a black terminal spot; remaining under surface of tail pale grey. Under shoulder-coverts, thigh-coverts, and inner webs of all the quills rufous. Bill black. Legs pale flesh-colour. Fourth, fifth, and sixth quills equal and longest; third and seventh equal and a little shorter; second a quarter of an inch shorter than third; first half the length of third. Tail 2 inches, wing $1\frac{7}{8}$, tarsus $\frac{11}{16}$.

From Coorg.

The broad ash-coloured pectoral band is a striking character in this species.

Megalaima inornata, n. sp.

The large green Barbet of South-western India has hitherto been confounded with that of Central India, *M. caniceps* (Franklin). That of South-western India, to which I give the above title, is to be distinguished from all the other known green Barbets by having the chin, throat, breast, and upper portion of the abdominal region uniform pale brown. Each feather has the shaft, very faintly, paler. The plumage above closely resembles that of *M. caniceps*; but the terminal spots on the wing-coverts and tertiaries are almost altogether wanting. The dimensions of both species are nearly alike, but the bill of *M. caniceps* (ex Maunbhoom) is shorter and not so stout. The absence of the broad pale median streaks on the pectoral plumage readily distinguishes this species.

Described from two Malabar examples, two from Coorg, and three from Candeish.

Buchanga leucogenis, n. sp.

General colour pale, delicate slate-grey, or French grey. Chin, narial plumes, and terminal portion of the primaries black. An oval patch on each side of the head, surrounding the eyes and extending from the base of the bill to beyond the cheeks, pure white. Bill and feet black. Wing $5\frac{1}{2}$ inches; tail $5\frac{1}{2}$. Immature birds have the grey tint more or less sordid, and the white facial patch indistinct.

This well-characterized species of Drongo has hitherto been mistaken for the *Dicrurus leucophæus*, Vieill.; but, as Vieillot's title was founded on Levaillant's 170th plate (Ois. d'Afr.), it must be referred to *D. cineraceus*, Horsf., over which designation it takes precedence. The *white-faced Drongo* inhabits Malacca, Cambodja, China, and Japan, being probably only a migrant to the two latter countries. The above description is taken from a Nagasaki example.

Buchanga mouhoti, n. sp.

Belongs to the "Ashy Drongos" (P. Z. S. 1866, p. 546), and was obtained by M. Mouhot in Cambodja. Above ashy grey or plumbeous, rather darker than in *B. leucophæa*, ex Java. Under surface lighter ashy, but darker than in the Javan species. Upper surface of middle rectrices grey, as in the Javan bird. Wing $5\frac{2}{8}$ inches; outer tail-feathers $5\frac{6}{8}$, middle tail-feathers $5\frac{2}{8}$; difference between outer and middle pairs $1\frac{4}{8}$; bill from nostril full $\frac{5}{8}$ of an inch.

A species intermediate in dimensions and colouring between *B. leucophæa* and *B. pyrrhops*, Hodgs.

Buchanga wallacei, n. sp.

Above dark ashy green, with a silky gloss. Underneath a shade lighter, but without any gloss, except on the breast. Upper surface of rectrices glossy greenish brown; no traces of ash-colour. Bifurcation of the tail moderate. Wing 5 inches to $5\frac{1}{8}$; outer tail-feathers 5 inches, middle pair 4 inches.

Described from specimens obtained in Lombock by Mr. Wallace.

XXIII.—*List of the Bones of Seals and Whales in the Colonial Museum, Wellington, New Zealand.* By Dr. James Hector, F.R.S. With Notes by Dr. J. E. Gray, F.R.S.

Seals.

1. *Stenorhynchus leptonyx*, Gray, Cat. Seals and Whales, p. 16. One skull. (Two stuffed specimens in the Dunedin Museum, one in Christchurch.)

This seal is not uncommon, several individuals being stranded on the east coast every winter.

Dunedin specimen described in Trans. New-Zealand Inst. vol. ii., by J. S. Webb.

2. *Arctocephalus leonina* (*Otaria leonina*, Gray, *ibid.* p. 59). Stuffed skin.

Common fur-seal of the west coast.

[It is very desirable that a skull of the fur-seal of New Zealand should be observed. It can hardly be *Otaria leonina*, which has only been found on the coast of South America, is a hair-seal, and has very little or no under-fur.—J. E. G.]

Cetacea.

1. *Balæna marginata*, Gray, *ibid.* p. 90.

Skull and baleen.

From the description given at page 90 of the British-Museum 'Catalogue of Seals and Whales,' there is no doubt that the baleen corresponds with the above species. The specimen was obtained at Kawau Island by Sir George Grey, and appears to be unique, as the species has hitherto only been known from the baleen.

The dimensions are as follows:—

Weight of cranium	58 lbs.	
" lower jaw	13 "	
	ft.	in.
Length	4	9
Front nasal section	2	10
To centre of orbit	3	10
Width at orbit	2	5
" mastoid process	2	7
	in.	lin.
Lower jaw, high	3	11
Depth (greatest)	8	0

Baleen 29 inches long, $3\frac{1}{2}$ inches in extreme width.
Black margin from $\frac{1}{4}$ to $\frac{3}{8}$ inch.

Knox now admits that this is not the Sulphur-bottom, which he says is the Trigger of the New-Zealand whalers. He fancies that *B. marginata* may be the true Finner of the south. I will try to find some more of the bones. I enclose a copy of Knox's description of the Trigger-whale, from a paper in course of publication.

[This whale, from the form and structure of the whalebone, cannot be a Finner, but is certainly, as I arranged it, a true Right Whale, very nearly allied to the Right Whale of Greenland, and of a very small size. The bones of this whale would be a most valuable addition to the British Museum or any zoological museum. They appear not to be uncommon in the Kawau Islands; and the measurements of the skull are a valuable addition to our knowledge of the species.

This small Right Whale of the Antarctic Sea is the representative of the Right Whale in the Arctic Sea, and, judging from the length of the head, cannot be more than 14 or 15 feet long, while the Greenland whale is from 50 to 65 feet long.—J. E. G.]

2. *Globiocephalus macrorhynchus*, Gray, *ibid.* p. 320.

Two skulls, one in longitudinal section; one lower jaw; six cervical, four lumbar, thirteen caudal vertebræ; two scapulæ; two hyoids. Both skulls are of the same dimensions:—

	inches.
Length	26
Length of nose	15
Length of tooth-series	8
Length of lower jaw	15
(This is of a different individual.)	
Width at notch	11
,, orbit	17
Width of intermaxillary at blow-hole	7·5
Width at middle of nose	9·5
Height at occiput	14
Scapula, transverse diameter	15
,, longitudinal diameter	12

Hyoid arch 11 inches wide by 7 inches high.

Sternum 10 × 7 inches—with three sternal ribs, each 7 inches long.

The first rib is 10 inches from head to tip, but is bent with an arch of 5 inches.

The atlas, axis, and three other cervicals are anchylosed. The compound cervicals have a conjoined length of 4 inches. Vertical diameter of foramen magnum $2\frac{1}{2}$ inches. Conjoined length of the four lumbars 8 inches; height, including spinous processes, 8·5 inches. Caudal apparatus, of thirteen segments, 16 inches; two of these are anchylosed. Teeth $\frac{9-9}{8-8}$.

3. *Berardius Arnuxii*, Duvernoy; Gray, *ibid.* p. 348.

Skull and lower jaw, a cervical vertebra, scapula, hyoid, paddles, and pelvic bones of one individual.

Single tooth of another individual, weight 206 grains.

	inches.
Length of head	23·5
,, nose	15
,, dental groove	7
,, lower jaw	19
Width at notch	5·5
,, orbits	9·5
Width of intermaxillary at blow-holes	4·5
,, nose	2
Height at occiput	9·5

One small tooth imbedded close to tip of lower jaw on left side, ·1 inch high, weight 38·8 grains, irregular triangular shape.

This is the skull of a young animal. A groove containing a strong ligament connecting the muscle of the forehead with the snout is deeply imbedded in the intermaxillary groove. The snout is described as long and flexible. Atlas and axis anchylosed. Length of cervical group 3·7 inches. Scapula, longitudinal diameter 10 inches, transverse diameter 6 inches. Paddles, length 14 inches, width 3½ inches. Hyoid arch 5·5 × 4 inches high. Pelvic bones 2½ inches.

The specimen was cast on the beach on the west coast, and prepared by Dr. Knox.

[This animal, which is at present unknown in Europe, and therefore very desirable to procure, does not appear to be uncommon in New Zealand. There is a skull, obtained in 1846, in the Museum at Paris.—J. E. G.]

"A fine specimen of *Berardius Arnuxii* has been cast ashore on the coast of Canterbury, New Zealand. It was made into a skeleton, which is now in the museum at Canterbury. The skeleton is complete, only wanting one of the pelvic bones. It was 30 feet long, and a young animal; not a single epiphysis is anchylosed. The cervical vertebræ, which in the old animal evidently form a compact mass, are still partly free; the first three vertebræ (including the atlas) anchylosed, and of these the first two completely, and of the 2nd and 3rd the neural arches are as yet not completely united into one bone. It has ten ribs."—*Julius Haast.*

4. *Lagenorhynchus clanculus*, Gray, *ibid.* p. 271.

Complete skeleton.

Length 5 feet 1 inch.
Cervicals seven, anchylosed, 1·3 inch.
Dorsals fourteen, 11·5 inch.
Lumbar and caudal forty-eight, thirty-four of which have processes and may be considered lumbars.

	inches.
Skull :—	
Length, total	14
Length of beak	7·5
Width at notch	3·5
,, orbit	6
Intermaxillary at blow-hole	2·7
Middle of beak	2·5
Height at occiput	5·7
Length of flappers	12
Scapula, longitudinal diameter	6·5
,, transverse ,,	4·5

This specimen was harpooned outside Wellington Harbour, and appears to be the common dolphin of the coast.

Two lower jaws of two other individuals of the same.

Three skulls of *Delphinus*, sp.?

Fossil Cetacea.

Fragments are abundant in the Pliocene marine Tertiaries; and several almost complete skeletons are known, but have not been removed from the rock. The fragments that are in the Museum cannot be referred to any class with certainty.

Extract from a paper by F. J. Knox. 1869.

Rorqualus. (Trigger, Razor-back, Sulphur-bottom.)

To be distinguished from the Finner, which is probably the *Balæna marginata.*

The fin in this species of the Balænidæ is placed in the usual position, immediately above the generative organs. It is said to average from 30 to 55 feet in length. The baleen is short, and the blubber in comparatively small quantity. This species resembles the great Rorqual in general habits, and, although numerous, does not form a tempting object of capture for the practical whaler. They are common in the neighbourhood of the New-Zealand group of islands.

Two young specimens were caught and stranded in Porirua harbour, thirteen miles north of Wellington, in 1867, neither of which I was able to preserve, only taking the measurements as detailed in the annexed tables. The dorsal surface was of a jet and glossy black, becoming of a light grey on the abdomen. The characteristic plaits or folds were well developed. The longest baleen blade was 2 feet, of a pale yellow or cream-colour. The osteology and comparative anatomy of this Rorqual were not ascertained.

A young female specimen; weight 300 lbs.

Measurements:—

	ft.	in.
Snout to tip of tail	9	10
Greatest circumference	6	8
Snout to nostrils	1	6·5
,, centre of eye	1	6
,, dorsal fin	5	2
Baleen (pale yellow or cream-colour), longest blade	2	0

[This is most likely the *Physalus antarcticus* of my 'Catalogue of Seals and Whales,' established upon some yellowish baleen imported from New Zealand.—J. E. G.]

BIBLIOGRAPHICAL NOTICES.

Index to the Fossil Remains of Aves, Ornithosauria, *and* Reptilia, *from the Secondary System of Strata, arranged in the Woodwardian Museum of the University of Cambridge.* By H. G. Seeley, of St. John's College, Cambridge. *With a Prefatory Notice* by the Rev. A. Sedgwick, LL.D. &c. &c. Pp. 143, 8vo. Cambridge and London, 1869.

The Woodwardian Museum holds a high place among Geological Institutions. It has been enriched by the careful gatherings and liberal gifts of the venerable Woodwardian Professor, and by the active cooperation and liberality of many University men and others following so good an example. It is well housed and cared for by the University and the Professor, as the illustrative material of the Cambridge school of Geology; and the well printed volume before us not only enhances the usefulness of the museum to students, but, as a classificatory catalogue of its precious collection of Reptilian remains, carefully allocated and critically determined, it supplies a standing-ground for herpetologists, whether working out their own views of the alliances of recent and fossil Reptiles, or following the plan of research indicated by Mr. Seeley's proposed relationships of the numerous osseous relics of new or ill-understood genera and species. Mr. Seeley separates the Pterodactyles and their fellows from the Reptilia as "Ornithosauria" (Pterosauria), and regards the Birds as an intermediate group. His views on the Pterodactyles are published in the 'Annals of Nat. Hist.,' and the specimens which he has already illustrated and described are indicated in this catalogue. Very many specimens described and figured by Professor Owen in the monographs of the Palæontographical Society are in this collection and are duly noted.

From the several tables in the List of Contents, pp. xi–xxiii, the reader gathers much information; thus there are:—1. The "Table of the Distribution of the large Groups of Animals in the Secondary Strata," as far as the mass of material in the Cambridge collection shows. 2. "Table of Secondary Strata, showing the larger Groups of Animals which they contain," as illustrated by the same collection; and it is rich in these osseous fossils from the Chalk, the Cambridge Upper Greensand, Gault, Potton Sands, Wealden Series, Purbeck Series, Portland Stone, Kimmeridge Clay, Coral-rag and Ampthill Clay, Oxford Clay, Great Oolite, and Lias. 3. "An approximate List of the Species included in the catalogue, with provisional names for new species and reference to the specimens on which they are founded, and to the pages of the Index in which they are described." These are arranged according to the geological formations. Thus from the Chalk we find one new species of *Ichthyosaurus*; from the Upper Greensand seventeen new species of a new Pterosaurian genus (*Ptenodactylus*), which comprises some of Owen's *Pterodactyli*, whilst another, accompanied by two new species, falls into Seeley's new *Ornithocheirus*. *Enaliornis* is a new bird-genus from the same formation. Three new species fall to Huxley's *Acanthopholis*, one of the Dinosaurs. *Macrosaurus* is a new Dinosaur. Four new species are added to the Ichthyosaurs. There is a new species of Crocodile; seven new Plesiosaurs; three new Steneosaurs. A new Chelonian genus (*Rhinochelys*) involves one of Owen's *Chelones*, and has sixteen species besides; and *Trachydermochelys* is another new genus from this exceedingly rich deposit of the remains of Mesozoic life.

A new *Iguanodon* (*Phillipsii*) from the Wealden is indicated. A new *Pterodactylus* and four new species of *Pleurosternon* are added from Purbeck. The Kimmeridge Clay yields a new terrestrial reptile (*Gigantosaurus megalonyx*), two new Ichthyosaurs, a new Dakosaur, two new Plesiosaurs, and a new Chelonian (*Enaliochelys*); and pages 102–105 are devoted to a critical examination of some vertebræ from the Kimmeridge Clay, that lead Mr. Seeley to refer Owen's *Plesiosaurus brachyspondylus* and *Pl. brachydeirus* both to *Pliosaurus*. Lastly, the new genus *Cryptosaurus* and some new species of Ichthyosaur, Pliosaur, Plesiosaur, and Steneosaur come from the Oxford Clay.

Great care has been taken in the preparation and production of this valuable catalogue*. The Prefatory Note by the reverend Woodwardian Curator and Professor shows his hearty earnestness in his work,—the pleasurable reminiscences of his collecting-days and fellow workers in years gone by,—his no less cordial appreciation of the researches and labours of the younger men who come and go with the tides of university life,—and his warm recognition of Mr. Seeley's zealous and patient study, some of the results of which are so conspicuously shown in this well-arranged and richly suggestive catalogue.

Professor Sedgwick intimates that other catalogues are in progress, and among them a more detailed catalogue of the Reptilian remains. It is by such adjuncts that a museum is made of value to students; and already the Woodwardian Professor has made great progress to this end, both with the catalogue before us and the magnificent work by himself and M'Coy on the British Palæozoic Fossils in the Cambridge Museum, published in 1852.

Mémoire sur les Ascoboles. Par M. E. Boudier. (Annales des Sciences Naturelles, cinquième série, tome x. 1868.)

M. Boudier has published an interesting account of the genus *Ascobolus* in the 'Annales des Sciences Naturelles' for 1868. It is the first time that that genus has been treated monographically, with the accompaniment of carefully drawn coloured figures, as well of the plants as seen by the unassisted eye, and slightly magnified, as of their fructification viewed under the higher powers of the microscope. M. Boudier traces the history of the genus from the

* By printer's error, probably, *procœlous* and *procœlian* are misspelt at pages 45 and 80.

time when Persoon described three species down to that when MM. Crouan added fourteen to those then known, in a paper in the 'Annales des Sciences' for 1857, and more recently five others in their 'Florule du Finisterre;' and Dr. Nylander carried on the number to forty-six in his 'Observationes circa *Pezizas Fenniæ.*' The *Ascoboli,* as is well known, derive their name from the fact of their projecting their asci above the surface of the hymenium at the time when the sporidia approach maturity. M. Boudier retains this character as common to several genera into which he divides the *Ascoboli* as hitherto constituted; he then proceeds to trace their development from an early period, describing the young conceptacles, their asci, and paraphyses, and, lastly, the sporidia. He attributes the projection of their asci above the hymenial surface to the action of endosmose, by which they absorb fluid from the surrounding medium, and from their elasticity are able to retain the accumulated liquid for some time, becoming gradually distended; the space where they originally grew becomes at length too narrow for their increased bulk, and they are pushed up on the shoulders of the younger asci. They then eject their sporidia through a circular or subtriangular operculum at their summit. Being relieved of their contents, they again contract and partly resume their former position. Describing the sporidia of the genus *Ascobolus,* M. Boudier says that, when mature, they acquire an epispore of a waxy (not membranaceous) consistence, as is shown by the effect of friction between two glasses, when the epispore breaks up into a mass of shapeless granules. We would call attention here to the structure of the epispore of *Ascobolus immersus,* P., or *A. macrosporus,* Cr., as shown in the 'Annals of Natural History,' ser. 3. vol. xv. pl. 17. fig. 33 *g**, where the epispore, being carefully removed, not crushed and broken up, exhibits a resemblance to cellular tissue. M. Boudier considers the veins or rugulosities, that are so remarkable a feature in the sporidia of *Ascobolus,* to be clefts or depressions caused by the shrinking of the epispore, but thinks them of little value for specific distinction, from their variability in the same species.

The account given of the sporidia, in their various phases, is complete and full of interest. In endeavouring to follow up the mode of their germination, M. Boudier observed only the mycelioid threads usual in other Fungi, but was unable to verify the fact asserted by M. Coëmans, viz. that the threads give origin to conidia of two sorts—one in the form of a *Torula,* the other of a *Penicillium. Penicillium glaucum* did, indeed, appear amongst his crops of *Ascoboli,* but he states it to be of extraneous origin. And where plants so mysterious as Fungi in the mode of their reproduction are in question, great care and repeated observation are necessary before facts such as those alluded to ought to be admitted. Nor was M.

* M. Boudier does not appear to have seen the paper by Messrs. Berkeley and Broome, in the 'Annals of Natural History' for April and May 1865, in which some species of *Ascobolus* are described that are omitted in his list.

Boudier more fortunate in his endeavours to confirm the views of M. Voronin (Abhandlungen der Senckenbergischen naturforschenden Gesellschaft, 1865, pp. 333, 334); but he saw the organs named "scolécites" by M. Tulasne (Ann. Sci. Nat. sér. 5. vol. vi. p. 211–220). He considers that the fertilization of the *Ascoboli* is still involved in much obscurity.

In arranging his materials systematically, he regards the *Ascoboli* as a division of the *Pezizæ* characterized by asci furnished with round or subtriangular opercula projecting above the hymenium when nearly mature, and sporidia clothed with a waxy, coloured epispore—or hyaline, and then having a membranaceous one, not granular within nor filled with oil-globules. He divides the old genus *Ascobolus* into two principal sections, consisting of the true, and the spurious or pezizoid species, deriving his characters from the organs of fructification:—the genuine, with coloured sporidia and projecting asci; the spurious, having hyaline sporidia and asci generally little exserted, and consequently an hymenial surface only slightly papillate. These two sections are distributed into six genera, viz. *Angelina, Ascobolus, Saccobolus, Thecotheius, Ryparobius*, and *Ascophanus*. The first contains only *Ascobolus conglomeratus*, Schwein. The last five are distinguished by the shape and position of the paraphyses and asci, and the nature and arrangement of the sporidia. The characters essential to the group M. Boudier considers to be an hymenium papillate with projecting, coloured, or hyaline asci, which open by an apical, round or subtriangular operculum, and sporidia rimose, with a coloured epispore, or with a membranaceous one, and then hyaline, not granular within, with a single nucleus, and without oil-globules. The author is thus compelled to exclude certain species, as *Ascobolus pulcherrimus*, Cr., *Ascobolus Crouani*, Cooke, and others. *A. Crouani*, Cooke, is referred to the section *Humaria* of the *Pezizæ*, on account of the globules present in the sporidia; but a reference to the figure of the fruit in vol. xxiv. of the 'Linnean Transactions,' p. 495, pl. 51, shows that the globules in question become eventually reticulations, or, at least, that they are not visible in the mature state of the sporidia. Nor is it very evident wherein *Ascobolus testaceus*, Wallr., differs from *Ascophanus carneus*, Boud. pl. 12. fig. 38. The genus *Ascobolus* is restricted to those species with much-exserted asci, conspicuous for their dark tips (from the colour of the sporidia) above the rest of the hymenium, opening by a round and umbonate operculum, and enclosing eight longitudinally rimose, free sporidia, which are either naked or adherent laterally to a membrane, or each enclosed separately and then subaggregate or easily separating, and paraphyses slender and longer than the asci.

The following species are included:—*Ascobolus lignatilis*, A. & S., *A. Crouani*, Boud. (the name having been given to *A. miniatus*, Cr., by Mr. Cooke, it adds to the confusion to have it again applied to another species); *A. denudatus*, Fr.; *A. viridis*, Currey; *A. furfuraceus*, P.; *A. vinosus*, Berk.; *A. cubensis*, B. & C.; *A. æruginens*, Fr.; *A. glaber*, P. (this species has occurred to us on rabbits' dung only—a habitat not recorded by M. Boudier; his plant seems nevertheless to be identical with our own. Unfortunately, M. Boudier does not give measurements of the sporidia, neglecting Dr. Nylander's advice in his treatise on the Pezizæ of Finmark, and thus depriving botanists of one valuable means of identification); *A. Leveillei*, Boud.; *A. porphyrosporus*, Fr. (is this species really distinct from *A. immersus*, P.? The description by Fries accords in many respects with that of *A. macrosporus*, Cr., or *A. immersus*, P.).

The genus *Saccobolus* has an hymenium dotted with black granules—the tips of the asci, which are less exserted than in *Ascobolus*. The paraphyses are equal in length to the asci. Asci short, subquadrate above and subcuneate below; operculum subtriangular, without an umbo. Sporidia eight, having a smooth or slightly and transversely rimose epispore, enclosed in a common membrane. The following species are included:—*Saccobolus Kerverni*, Boud.; *S. violascens*, Boud.; *S. neglectus*, Boud. (this species is very near if not identical with *Ascobolus depauperatus*, B. & Br., Ann. Nat. Hist. ser. 3. vol. xv. p. 448, t. 14. fig. 6); *S. globulifer*, Boud.

The following *Ascoboli* of various authors are not incorporated in M. Boudier's genera, from want of clearness in their characters:—*A. sphæricus*, Preuss.; *A. Daldinianus*, De Not.; *A. rufo-pallidus*, Karst.; *A. lapponicus*, Karst. The *Ascoboli spurii* of M. Boudier follow. *Thecotheius*, having an erumpent hymenium, rough with crystalline prominences (the tips of the much-exserted asci), filled with hyaline sporidia; *Thecotheius Pelletieri*, Boud., the only species. *Ryparobius* has a very minute receptacle, few paraphyses, and large many-spored asci, opening by a large convex operculum not much exserted: *Ryparobius brunneus*, Boud., *R. Cookei*, Boud., *R. felinus*, Boud., *R. dubius*, Boud., and *R. myriosporus*, Boud., constitute the species of this genus. The genus *Ascophanus* follows, with an hymenium papillate with crystals from the slightly exserted asci, equalling the paraphyses in length, and enclosing eight, or in one species sixteen, ovate-oblong, hyaline sporidia. The species are:—*Ascophanus minutissimus*, Boud.; *A. Coëmansii*, Boud., which seems not to differ from *Ascobolus microsporus*, B. & Br. *l. c.* p. 449, except in the colour of the mature sporidia; (we may observe that *Ascobolus pilosus*, Boud., or *A. ciliatus* of some writers, has sporidia of a dark violet-colour when mature, which M. Boudier does not appear to have noticed, as it would exclude it from his genus *Ascophanus*;) *A. granuliformis*, Boud.; *A. argenteus*, Boud.; *A. vicinus*, Boud.; *A. ochraceus*, Boud.; *A. sexdecemsporus*, Boud.; *A. aurora*, Boud.; *A. cinereus*, Boud.; *A. carneus*, Boud., which comes very near to *Ascobolus testaceus*, Wall.; *A. saccharinus*, Boud.; *A. difformis*, Boud., synonymous with *Ascobolus testaceus*, Karst., and possibly identical, M. Boudier thinks, with *Ascobolus saccharinus*, Currey; *A. papillatus*, Boud.; *A. ciliatus*, Boud.; and *A. pilosus*, Boud. Among spurious and doubtful *Ascoboli* is placed *A. miniatus*, Preuss. And excluded species follow, viz.:—*A. pulcherrimus*, Cr., doubtfully referred to *Peziza subhirsuta* or *P. stercorea*; *A. insignis*, Cr., referred to the same group of Pezizæ; *A. Persoonii*, Cr., referred to *Peziza*, section *Humaria*; *A. Crechqueraultii*, Cr., also placed in *Humaria*; *A. Crouani*, Cooke, placed in the same section on account of its granular sporidia, but which, as indicated above, is only the immature condition, and, from its reticulated sporidia, should probably be placed in a new genus; *A. Guernisaci*, Cr., not placed, but excluded from *Ascoboli* on account of its non-prominent asci, &c.; *A. Brassicæ*, Cr., repudiated, owing to its granular sporidia, although they are violet-coloured; *A. microscopicus*, Cr., not placed; *A. coccineus*, Cr., referred, in part, to *Peziza convexula*, P.; *A. Leveillei*, Cr., a doubtful *Ryparobius*. *Peziza cunicularia*, Boud., will hereafter, as the author thinks, constitute a new genus. *Ascobolus trifolii*, Bivona, is united with *Phacidium*. *A. atrovirens*, Nees, is *Peziza atrovirens*, P. *A. Burcardia*, Martius, is *Bulgaria globosa*. *A. coronatus*, Schum., is *Phacidium coronatum*, Fr. *A. inquinans*, Nees, is *Bulgaria inquinans*, Fr. *A. rhizophorus*, Spr., is *Rhizina lævigata*, Fr. *A. sarcoides*, Nees, is *Bulgaria sarcoides*, Fr. *A. testaceus*, Wallr., is *Peziza testacea*, Mougt. *A. vitis*, Wallr., is *Peziza albo-violascens*, A. & S., and also *Cyphella Curreyi*, B. & Br.

Of the genus *Ascobolus*, as limited by M. Boudier, we have two new species, *A. Crouani*, Boud., and *A. Leveillei*, Boud.; of *Saccobolus* three—*S. violaceus*, Boud., *S. neglectus*, Boud., and *S. globulifer*, Boud.; of *Ryparobius* three—*R. brunneus*, Boud., *R. felinus*, Boud., and *R. dubius*, Boud.; of *Ascophanus* two—*A. minutissimus*, Boud., and *A. vicinus*, Boud.: in all, ten new species, which, added to those included by various authors in the old genus *Ascobolus*, bring up the number of species to forty-three, besides nine belonging to other genera, of some of which the true position has not yet been determined.

M. Boudier's figures are very faithful, so far as we are acquainted with the species described, and are carefully and artistically executed; and the whole paper is essential to all who wish to become acquainted with these plants. It is to be regretted that the author has not availed himself of the characters offered by the micrometer; we would notwithstanding recommend all those who take up mycology to procure the treatise without delay.

MISCELLANEOUS.

On the Genus Asterostoma, *belonging to the Family* Echinocorydeæ. By M. G. Cotteau.

Among the very interesting fossils from the island of Cuba sent to Paris for the Exhibition of 1867, by MM. Fernandez de Castro and Jimeno Francisco of Matanzas, there were two species of Echinida belonging to the genus *Asterostoma*, Agassiz. These Echinida, which are very remarkable for their form and the totality of their characters, thanks to the kindness of M. Jimeno, to whom they belonged, now form part of my collection; and I have been able, by examining them at leisure, to complete the diagnosis of the genus and determine the place which this curious type should occupy in the series.

Before the Exhibition of 1867, only a single specimen of *Asterostoma*, from Lamarck's collection, was known. In 1847 MM. Agassiz and Desor, in the 'Catalogue raisonné des Echinides,' had made of this unique specimen the type of the genus *Asterostoma*, and given the species the name of *excentricum*. Although noticing that this genus approaches *Echinocorys* (*Ananchytes*, Lamk.) and that the anterior ambulacral area is formed of smaller pores than the paired ambulacral areas, MM. Agassiz and Desor place the genus *Asterostoma* at the end of the family Cassidulidæ, not far from *Conoclypeus*. In 1865 D'Orbigny described the genus *Asterostoma* and the only species which it then contained. Because the anterior ambulacral area differed from the others, not only in its form but also in the structure of its pores, the author of the 'Paléontologie Française,' justly considering this organic character very important, thought that the genus must be placed among the Spatangidæ, in which, as is well known, the anterior ambulacral area is never like the others.

Some years later, M. Desor, in the 'Synopsis des Echinides fossiles,' had again to turn his attention to *Asterostoma*. That eminent naturalist discusses and combats the opinion of D'Orbigny: the position of the peristome, which is almost central in *Asterostoma*, the strongly marked furrows which surround it, and of which no trace exists in the true Spatangidæ, and the structure of the apical apparatus, which, from the impression left at the apex of the ambulacral areas, appeared to affect an elongated form, led M. Desor to remove the genus *Asterostoma* from the Spatangidæ; and it appeared to him much more natural to unite it with the Galeritidæ, near *Desorella* and *Pachyclypeus*, which, as he says, combine with a central and angular peristome an elongated apical apparatus.

The two new species of *Asterostoma* which I have just studied, from the fine preservation of some of their essential organs (the paired and anterior ambulacral areas, the peristome, the apical apparatus, &c.), whilst enabling me to complete the diagnosis of the genus, leave me in no doubt as to the place which it should occupy; and I have no hesitation in ranging it in the family of the Echinocorydeæ, between *Stenonia* and *Holaster*. That important character upon which D'Orbigny dwelt, namely the difference of structure between the anterior ambulacral area and the others, is still more apparent and marked in our two new species. It is not only the ambulacral pores that are smaller and otherwise arranged in the anterior ambulacral area; the poriferous plates themselves are higher and consequently much less numerous; and this clearly marked difference gives to the upper surface a physiognomy which is certainly not that of the Echinobrissidæ and Echinoconidæ. M. Desor, to support his opinion, especially invoked the almost central position of the peristome and the deep furrows which converge into it. In the new Asterostomas from Cuba, the peristome is much more excentric in front, the ambulacral furrows which surround it, although still present, are less apparent and not so much produced, and the lower surface, in its general aspect, presents much resemblance to that of *Holaster* and *Echinocorys.* The apical apparatus is perfectly preserved in one of our species (*A. cubensis*); it is not elongated, as M. Desor supposed, but compact and subcircular.

To sum up. The genus *Asterostoma*, by its general characters, the anterior ambulacral area different from the others, the subpetaloid paired ambulacral areas, the transverse peristome, which is most frequently very excentric in front, and the rounded periprocta, situated on the posterior surface above the ambitus, takes its place in the family of the Echinocorydeæ; its compact apical apparatus, furnished behind with an angular complementary plate, which penetrates to the centre of the apparatus, seems to approximate it to the true Spatangidæ; but it must not be forgotten that if *Echinocorys*, *Holaster*, and *Cardiaster* have an elongated apical apparatus, there is also among the Echinocorydeæ the genus *Stenonia* which, although very nearly allied to *Echinocorys*, has nevertheless a compact and subcircular apical apparatus.

The genus *Asterostoma* includes three species, which, although presenting numerous points of resemblance, are nevertheless perfectly distinct:—

Asterostoma excentricum, Agassiz.
—— *Jimenoi*, Cotteau.
—— *cubensis*, Cotteau.

We do not know positively the deposit from which the species of *Asterostoma* are obtained. The specimen in the Paris Museum bears no indication of locality; it is penetrated by a hard, compact, greyish limestone, which, according to D'Orbigny, indicates a bed older than the Tertiary formation, and may be Cretaceous. The specimens collected in Cuba by M. Jimeno are also derived from a hard, greyish rock; but this petrographic character is certainly not sufficient to refer them to the Cretaceous formation. Zoological characters furnish more conclusive arguments. The family Echinocorydeæ, in which I have placed *Asterostoma*, has hitherto included only exclusively Cretaceous genera; and, on the other hand, the genus *Asterostoma*, considered in itself, departs in its general characters from all the Tertiary or living types that we know. It may, therefore, probably belong to the Cretaceous formation; but these are only presumptions, and to obtain more certainty we must wait for the stratigraphical information for which I have asked M. Jimeno.—*Comptes Rendus*, February 7, 1870, tome lxx. pp. 271–273.

Sars Fund.

The appeal for assistance to the family of the late Professor Sars has been most satisfactorily responded to here and in France; and the subscription lists comprise the names of all the principal zoologists and geologists, as will be seen by our advertising columns as regards this country. The French list (including Belgium) amounts to about 5000 francs, or £200 of our money.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FOURTH SERIES.]

No. 28. APRIL 1870.

XXIV.—*On the Structure and Development of the Antheridium in Ferns.* By Dr. L. Kny*.

[Plate VI.]

The structure of the antheridium of Ferns, notwithstanding its great simplicity, has experienced the most various interpretations.

Nägeli, the discoverer of the organ, describes it† as a gland-like structure, which is frequently apparently unicellular, but generally presents distinctly the form of a sac surrounded by a simple cell-layer, in the interior of which the mother cells of the spiral filaments are produced. It originates from *one* mother cell. After this has projected itself above its neighbours, it first of all divides by a horizontal septum. This first septum is followed in the outer cell by a second, parallel to it. The same process may be repeated once or twice in the successive outer cells. By these divisions a Conferva-like cellular filament of from two to five cells is produced. Each joint becomes broken up into a central cell with four peripheral cells surrounding it. The peripheral cells of all the successive joints form four perpendicular rows, and combine to form a sac-like envelope; the central "spaces" together represent a "canal," in which the mother cells of the spiral filaments are produced. This is closed below by the cell of the prothallium to which it is attached, and above by the four cells of the last joint, which have not completely separated from each other. The apical and basal joints sometimes remain undivided.

When the mother cells of the spiral filaments appear to be

* Translated by W. S. Dallas, F.L.S., from the 'Monatsbericht der Kön. preuss. Akad. der Wiss. zu Berlin,' May 1869, pp. 416–431.

† Zeitschr. für wissenschaftl. Botanik, Bd. i. (1844) p. 168 *et seqq.*, Taf. 4.

enclosed merely by a simple or double membrane, this, according to Nägeli, is always the consequence of the preponderant increase of volume of the contents of the antheridium, and of a compression of the enveloping cells thereby produced. After the evacuation of the spiral filaments, these cells again extend themselves.

Count Leszczyc-Suminski * states that a free cell is produced in the interior of the mother cell of the antheridium as this is arching itself up above its neighbours, and that the contents of this, a homogeneous mucilage, show limpid globules or distinct nuclei furnished with nuclear corpuscles. As soon as this cell has advanced in its growth so far as to fill the walls of the original projection, it shuts itself off from the cells of the prothallium. Frequently a third, flattened cell is formed between the two; this serves as the bearer of the one-celled antheridium. The mother cells of the spiral filaments are produced within this by free cell formation. Count Leszczyc-Suminski, indeed, also figures (Taf. 2. fig. 15) an antheridium with a distinct cellular envelope; but he describes this, in the explanation of his figures, as a morbid state.

Wigand † speaks very decidedly in favour of the unicellularity of the antheridia of ferns, which he investigated in several species, some of which, however, are not exactly defined. According to him, they are frequently produced by the direct metamorphosis of cells of the prothallium, without any previous separation of an anterior elevated portion from the great mass of the cells; but usually the latter occurs. How the mother cells of the spiral filaments originate, whether by division or free cell formation, Wigand leaves undecided.

Schacht ‡ never found the antheridia unicellular in the species investigated by him (*Pteris serrulata*, *Asplenium Petrarcæ*, *Adiantum formosum*, and *Aspidium violaceum*); the nucleus was always enveloped by a single layer of limpid cells. In his adhesion to Schleiden's opinion of the general occurrence of free cell formation, he supposes these cells of the wall to be produced as vesicles in the interior of the mother cell. One of them is assumed to become the primitive mother cell of the cells of the spiral filaments, which latter are also produced by free cell formation. At the conclusion of his description, Schacht himself expresses some doubt as to the accuracy of his observations.

* Zur Entwickelungsgeschichte der Farrnkräuter (1848), p. 10.

† Botan. Zeitung, 1849, p. 22.

‡ "Beitrag zur Entwickelungsgeschichte der Farrnkräuter," Linnæa, 1849, Bd. xxii. p. 758 *et seqq.*

Thuret* conceived the structure of the antheridia quite differently from all previous observers, and, as we shall soon see, was the first to take a correct view of them. In most Polypodiaceæ they consist, according to him, of three superimposed cells—a peduncular cell, which attaches the organ to the prothallium, an annular cell, which encloses the mother cells of the spermatozoids all round, and a terminal opercular cell. In many cases the inner space of the antheridium reaches down to the surface of the prothallium, so that the basal cell also becomes an annular cell. How these annular cells are produced, whether they are formed as such at once, or owe their origin to the coalescence of several cells, is a question which Thuret leaves untouched.

Mercklin†, who, of all the observers hitherto mentioned, had the most abundant material at his disposal, follows Nägeli essentially in the interpretation of his observations, and rejects Thuret's conception (p. 18); whilst Mettenius‡ unconditionally agrees with the latter, and refers only to Thuret with regard to the structure of the antheridium.

According to Hofmeister§, there occurs in the mother cell of the antheridium a division by an inclined partition, either immediately or after one or (rarely) more divisions have taken place in it by transverse septa. The newly formed cell of the second degree divides at once by a radial longitudinal wall. After a single repetition of the division of the apical cell by a septum inclined in an opposite direction, the longitudinal growth of the antheridium ceases. The second cell of the second degree is also divided by a radial septum into two parts, of the form of quadrants of a cylinder. Next one of the cells of the third degree is divided by a septum parallel to the longitudinal axis of the organ, and cutting the side walls at an angle of 45°. The antheridium now forms a semiglobular cellular body, consisting of a four-sided central cell filled with granular plasma, supported by one cylindrical or two semicylindrical cells, enveloped by four cells of the form of segments of a cylinder, and covered by a cell of the form of the segment of a sphere. . . . The cells of the antheridium which embrace the central one increase no further. The central cell, on the other hand, after considerably increasing in size, in consequence of which the cells surrounding it are flattened

* "Sur les Anthéridies des Fougères," Ann. Sc. Nat. sér. 3. tome xi. (1849) p. 7.

† Beobachtungen an dem Prothallium der Farrnkräuter (1850), p. 12 *et seqq.*

‡ Beiträge zur Botanik (1850), p. 22.

§ Vergleichende Untersuchungen, &c. (1851) p. 79.

into a tabular form, becomes converted by a series of bisections into a globular group of cubical cells.

Henfrey*, who does not appear to have been acquainted with Thuret's work, not only gives a description of the structure of the antheridia agreeing with his throughout, but goes a step further, and endeavours to ascertain the *mode of production of the annular cells.* According to his observations, there is formed in the mother cell of the antheridium, either immediately or only after the separation of a basal cell has taken place, an erect ring-like partition, which makes its appearance simultaneously at all points. The rudimentary antheridium now consists of an inner cylindrical cell and a hollow cylindrical cell enclosing this. A horizontal septum applies itself to the upper part of the annular partition; and by this the opercular cell, which is convex above, is separated from the central cell. If the latter (or the products of its division) be subsequently enclosed by *two* annular cells, these, according to Henfrey, are always produced by the division of the first formed annular cell by means of a septum running round horizontally.

It will appear from what follows that my observations do not confirm the developmental history given by Henfrey.

Wigand, in a second memoir†, in continuation of his previous communication, gives comparative observations upon the structure of the antheridium in many species of ferns. For a certain number of cases he maintains his previous opinion of the unicellularity of the entire organ. In most species he admits the existence of a proper antheridial wall, which embraces the mother cells of the spermatozoids either on all sides or only in part. The closed rings, the presence of which did not escape him, are described by him as "circles of peripheral cells." The number of cells united to form a circle is, according to him, usually four, sometimes five or six (*l. c.* p. 46).

Hofmeister‡ affirms, in opposition to Henfrey, that he had repeatedly convinced himself of the correctness of his previous statements upon the developmental history. Hollow cylindrical cells are certainly recognizable in nearly mature and in emptied antheridia; but these, he says, are produced by the lateral fusion of several cells by the absorption of their transverse partitions.

* "On the Development of Ferns from their Spores," Trans. Linn. Soc. vol. xxi. p. 121.

† "Weitere Beobachtungen über die Keimungsgeschichte der Farrn," Botan. Untersuch. 1854, p. 44 *et seqq.*

‡ Beiträge zur Kenntniss der Gefässkryptogamen, ii. p. 604, note.

The last explanation of the development of the fern-antheridium which Hofmeister gives, in the English edition of his 'Vergleichende Untersuchungen'*, does not differ essentially from his former one. He says, "The analogy to be derived from the process of development of the antheridia of the Muscineæ renders it probable that the large central cell is formed by the production of an excentrical, inclined, longitudinal septum in the young antheridium, followed by the production of another excentrical septum cutting the latter at right angles, and the subsequent formation of a longitudinal septum cutting both the above at an angle of 45°, such formation taking place after the apical cell of the antheridium has been isolated by a strongly inclined, almost horizontal septum cutting the primary longitudinal septum. When the central cell is surrounded by two zones of enveloping cells, it is manifest that the two zones originate in the transverse division of the primary single zone."

Lastly, Strassburger† has occupied himself with the present subject. In *Pteris serrulata*, according to him, the mother cell of the antheridium is divided first of all by two oppositely inclined septa, which are set obliquely upon the bottom of the antheridium and cut its side walls nearly at their summit. "These first two septa are soon followed respectively by two other opposite ones, cutting them at an angle of 45°. All these four septa are strongly inclined together towards the base of the antheridium, without, however, absolutely meeting there; and in this way a central quadrangular space is cut off, which is widened above in a funnel-like form. The upper part of the antheridium is still unicellular; but a number of divisions soon occur in it. First of all, four upper lateral cells are produced in exactly the same way as the inferior ones; they are set upon these inferior ones, and inclined together towards the apex of the antheridium. Finally, between these upper lateral cells an opercular cell, of the form of the segment of a sphere, is separated from the vertex of the antheridium. In this way a cellular body is formed, consisting of a central cell, eight lateral cells, and an opercular cell. The central cell, seen from above, is quadrangular, bellied out in the middle of its height, gradually diminished towards its extremities, especially the lower one, and it becomes the primitive mother cell of the spermatozoids. It contains an abundance of protoplasm and a distinct cell-nucleus, whilst the lateral cells as yet contain only a few chlorophyll-grains."

* On the Germination, Development, and Fructification of the higher Cryptogamia (London, 1862), p. 186.

† "Die Befruchtung bei den Farrnkräutern," Mém. de l'Acad. de St. Pétersb. 1868, p. 2.

My own investigations as yet relate only to a few species. Nevertheless, to judge from the statements and pictorial representations contained in the literature of the subject, the most important differences in the structure of the antheridium are represented by them. In a short time I hope to be able to complete my observations upon most of the genera of Filices. It scarcely needs to be mentioned that I have not obtained the materials for my investigation from the impure cultivated forms of the fern-houses, but that the sowings have been made specially for my purposes, and carefully protected from foreign interlopers.

Aneimia hirta possesses antheridia which are remarkable for their considerable size and simple structure. In the mature state (Pl. VI. fig. 5) they consist of a depressed cylindrical stalk cell, a comparatively elevated annular cell set upon this, in which no indication of a longitudinal septum is visible, and a low opercular cell in the form of the segment of a sphere. The inner cavity enclosed by the three cells is filled by the special mother cells of the spermatozoids.

On weakly prothallia growing very close together they spring in about equal abundance from the underside of the leafy surface and from the margin. In the last-mentioned position their development is easily ascertained by the comparison of different stages.

The youngest observed rudiments, which scarcely projected as hemispheres above the margin (fig. 1), and in the fresh state appeared to be uniformly filled with turbid protoplasm, proved, on closer examination, to be not only separated from the marginal cell by a septum, but even already to consist of three cells. The lower, peduncular cell, which is greatly curved inwards, is bounded by two parallel walls, of which the superior is the youngest. Upon this follows a watch-glass-shaped septum curved outwards in a circle concentric with the peripheral boundary of the peduncular cell, cutting off an inner cell of the form of a biconvex lens from a shallow bell-shaped cell which covers it. Whilst the peduncular cell scarcely becomes perceptibly elongated, the two other cells both become strongly arched outwards. At the same time the septum separating them long remains very delicate, so that it eludes direct observation (fig. 2 *a*); when the prothallium is treated with solution of potash and muriatic acid, it makes its appearance quite distinctly (fig. 2 *b*). About the time when the inner cell has acquired a hemispherical form, there is produced in the bell-shaped cell covering it a funnel-shaped septum widening upwards, which is applied both to the inner and outer wall, in a closed circle. Its formation appears to be perfectly simultaneous. By it the opercular cell is separated from the hollow cylindrical enveloping cell (ring cell).

In each of the four cells of which the antheridium is composed in this state of development, a nucleus is distinctly recognizable. In the opercular cell it is applied to the lower septum, and is surrounded by numerous chlorophyll-grains; in the ring cell it clings to the inner wall on one side; in the central cell it occupies exactly a middle position, and, on account of the abundance of chlorophyll and protoplasm, appears only as a lighter spot.

The central and ring cells grow predominantly in length and less in circumference. At the same time the inclination of the septum which separates the latter from the opercular cell becomes somewhat less. Whilst all the other cells remain undivided, the central cell is broken up, by a number of successive divisions, into the special mother cells of the spermatozoids. The position of the septa with regard to the longitudinal axis of the organ and to each other is now rather irregular, as may be seen from figs. 3 & 4.

The cells of the last generation round themselves off from each other, in the manner characteristic of the special mother cells, until they become completely isolated. Within the delicate cellulose membrane there is first a layer of hyaline protoplasm; towards the middle numerous granules are imbedded in the plasma. The evacuation of the special mother cells always takes place through an irregular rupture of the opercular cell. The torn fragments of the membrane of this shrink together, and soon become unrecognizable. The gradual appearance of the cellular contents is accompanied by a considerable extension of the basal cell and ring cell (Pl. VI. fig. 6). This renders it probable that the opening of the antheridium is effected chiefly by the turgescence of these two cells. In the membrane of the ring-cell, which at the same time becomes much shortened, folds are formed in larger or smaller number, which, when seen from above, do not usually extend beyond half the thickness of the ring (fig. 7), but in a side view sometimes present a deceptive resemblance to true septa. I suppose that these have played a great part in the erroneous representations of the structure and development of the antheridium of ferns. That the ring cell is not, as supposed by several of the observers above mentioned, produced by the amalgamation of four or more originally separate peripheral cells, but is a ring cell from its first foundation, is perfectly evident from the constant presence of only *one* nucleus. Even after evacuation has taken place, this remains for some time distinctly recognizable (fig. 6).

The antheridia of *Ceratopteris thalictroides* (figs. 8–10) are at the first glance very dissimilar to those of *Aneimia*. On closer examination, it appears that the difference lies more in the dimensions of the individual parts than in any divergence of structure. Most of the antheridia here originate from marginal cells of the prothallium; only a few are developed upon the lower surface of the frond. In the former, the only one which I have closely traced, the divisions of the mother cell are completed at a period when it scarcely projects perceptibly above its neighbours.

The first septum is usually unsymmetrical and strongly curved. It is attached on the one side to the free outer wall of the mother cell, and on the other to one of the side walls which separate this from the neighbouring cells. The lower cell thus cut off of course extends only on one side to the free margin of the prothallium (figs. 9 *a*, 10). Unfortunately I have no direct observation of the next step in division. From the mature state, in conjunction with the undoubtedly ascertained process of development in *Aneimia hirta*, I think I may conclude that here also the first-formed wall is followed by a watchglass-shaped membrane, which separates an inner cell of the form of a biconvex lens from an outer shallow bell-shaped cell. In the latter, as in *Aneimia*, a funnel-shaped septum widening upwards would then be produced, isolating the opercular cell from the ring cell. The latter here always remains short and at the same time slightly curved downwards. This, combined with the want of a true peduncular cell, is what chiefly causes the peculiar habit of the antheridium of *Ceratopteris*.

Divergences from the structure just described but seldom occur. The commonest is, that the first septum attaches itself symmetrically to the two lateral walls (fig. 9 *b*) instead of only to one of them. Only in the rarest cases have I observed mature antheridia in which the separation of the ring cell and the opercular cell had been omitted, and in which, therefore, the special mother cells were enclosed in a lenticular space between two cells.

Asplenium alatum possesses antheridia in which the nucleus is usually enclosed by *two superimposed* ring cells (Pl. VI. figs. 14 & 15). The operculum, as in *Aneimia hirta* and *Ceratopteris thalictroides*, is unicellular. A peduncular cell is not always present (figs. 11, 14, & 15).

On the weakly prothallia examined by me (which had been much crowded during growth) the antheridia were developed chiefly on the surface of the frond, frequently in such abundance that every cell bore an antheridium. They were produced less numerously on the marginal cells. Their development could be best traced on filiform adventitious shoots, of which each ramification, often, terminated with an antheridium (fig. 13).

The youngest rudiments observed by me were hemispherical. The first septum that makes its appearance in them has the form of a funnel; it attaches itself to the flat basal surface, in a narrow circle concentric with the peripheral boundary of the latter, and widens upwards so as to strike (also in a closed circle) about the middle of the spherically arched outer wall (figs. 11, 12). The lower (and at the same time the outer) of the two sister cells, which, even at its formation, possesses the form of a ring widened at the base and narrowed to an edge above, retains this essentially; it is afterwards incapable of any further division. The other sister cell, which is conically narrowed at its lower end, distinctly exhibits a cell-nucleus in this lower part. Its increase in length takes place exclusively in its upper, free half. If a young antheridium in this stage of development, when the upper part begins to distinguish itself slightly, even in external contour, from the first annular enveloping cell (fig. 13 *a*), be treated with diluted solution of caustic potash, and, after being once washed, with muriatic acid, we observe a delicate divisional line, to which a cell-nucleus is applied both above and below (fig. 13 *b*). This septum, which separates a superior shallow bell-shaped cell from the central cell (the primitive mother cell of the spermatozoids), applies itself on all sides to the upper margin of the first-produced funnel-shaped cell-wall, and is slightly curved upwards in the form of a meniscus.

Simultaneously with the further longitudinal growth of the young antheridium, a stronger arching of this septum takes place. After it has become about parallel to the free outer wall, an annular wall, becoming slightly widened upwards in a funnel-shape, attaches itself almost at right angles to the upper surface at an equal distance from the vertex all round (fig. 14).

By this means the bell-shaped cell is divided into an inferior ring cell and a superior opercular cell, the latter presenting the form of a truncated cone with its spherical basal surface turned upwards. With this the development of the antheridial envelope, in the great majority of cases, is concluded. Both the ring cells, as well as the opercular cell, show a nucleus, which is distinctly recognizable upon careful examination. Even after the evacuation of the antheridium, this is still retained for some time in the ring cells (fig. 17).

It is only after the foundation of the antheridial envelope that a series of divisions takes place in the central cell, leading to the formation of the special mother cells. The first septa are usually directed exactly in accordance with the longitudinal axis of the antheridium, and placed at right angles to each other in three directions; afterwards radial walls alternate several times with tangential ones. The cells of the last grade, the number of which is not constant, become rounded off from each other. Their very delicate membrane is followed, immediately within, by a hyaline plasma-zone; the central part of the contents is distinctly granular.

The opening of the antheridium is here also evidently effected by the turgescence of the two ring cells. After the opercular cell is irregularly ruptured, and the special mother cells are evacuated, these extend themselves inwards, at the same time becoming slightly shortened. By this means are formed radially perpendicular folds, which, when looked at laterally, often present a delusive resemblance to true septa in appearance*. Here also, as in *Aneimia hirta*, we may easily convince ourselves, by examination from above, that they do not attain the outer membrane.

Exceptionally we sometimes observe antheridia with only *one* ring cell. This has then, so far as the mature state enables us to judge, exactly the same origin as the *upper* ring cell in normal antheridia: it is the sister cell of the opercular cell.

Rather more frequently antheridia with *three* ring cells are observed. The middle one, in this case, is probably formed by a funnel-shaped septum in the same way as the lower one. This was certainly the case in two abnormal antheridia, in which the second ring cell had attached itself laterally and obliquely to the lower one (fig. 16).

Cibotium Schidei directly approaches *Asplenium alatum*, but shows some remarkable peculiarities. The lowest of the two ring cells, which are here present in the great majority of the antheridia, usually rests upon a basal cell which is only developed on one side, and is then lower upon one side than on the other, whilst the upper ring cell is more regularly developed (fig. 19). The opercular cell does not remain undivided, but is divided into two daughter cells of unequal size by a wall, which is perpendicular to the outer wall, but strongly convex towards the middle point of the cell. The larger cell is crescentiform, the smaller one elliptical, pointed at both

* In two cases I believe I positively ascertained the presence of a single true longitudinal wall in one of the ring cells. I regard them as supplementary structures. As to the mode of their production, I can, unfortunately, say nothing further.

ends (fig. 18). In the smaller of the two sister cells a further division sometimes takes place. It is either divided into two equal parts by a wall perpendicular to the last-formed one, or an oppositely curved wall attaches itself on both sides to the first wall. The operculum is then composed of a central and two peripheral cells. Rarely the second wall of the operculum is parallel to that first formed.

At the opening of the antheridium the operculum is not irregularly ruptured as in *Aneimia hirta*, *Ceratopteris thalictroides*, and *Asplenium alatum*, but the smaller cell, or, when it consists of three, one of the two smaller cells, is separated from its union with the neighbouring cells, and thrown back like a valve.

The structure of the ring cells, so far as I could observe, is perfectly analogous to that described in *Asplenium alatum*; here also the lower one is essentially different in its origin from the upper one. The lower one is cut off directly by a funnel-shaped septum from the primitive mother cell of the antheridium, whilst the upper one, with the operculum (which is afterwards pluricellular), is the product of division of a bell-shaped cell.

The process of development of the antheridia of *Osmunda regalis* differs completely from the examples above described. Closed ring cells never occur in it. The mother cell is first of all divided by an oblique wall, which is slightly concave inwards and is followed in the upper and larger of the two sister cells by a second wall inclined in the opposite direction; only in rare cases three successive walls are formed, and these then diverge at angles of 120°. Whilst the peripheral cells undergo no further division, in the inner and at the same time superior cell a septum, nearly perpendicular to the longitudinal axis of the antheridium and slightly concave below, is formed, and attaches itself to the first-formed septa on all sides. The central cell is then broken up by a series of divisions, in which no definite rule can be recognized, into the special mother cells of the spermatozoids; the opercular cell is divided at the same time, by several walls running in the same direction across its vertex, into three or four cells, the outer contour of which usually becomes waved by subsequent extension. They form the greater part of the wall of the antheridium*.

The interest attaching to the facts above communicated goes far beyond the developmental history of the Ferns. As far as I know, cells in the form of closed rings have only been observed in the mature fronds of some species of *Aneimia*,

* I shall give a more detailed account of the antheridia of *Osmunda* in a memoir which will shortly appear in Pringsheim's 'Jahrbuch.'

where they surround the pair of closing cells of the stomata. With regard to the mode of their formation, there is a still unsettled difference of opinion between Hildebrand* and Strassburger†; but both of them agree in thinking that the ring cells are not formed as such, but only acquire their peculiar form subsequently. The antheridia of the Polypodiaceæ and Schizæaceæ consequently present the first example of a *direct production of ring cells by the formation of funnel-shaped septa*; they show at the same time that this process, which has hitherto been quite isolated in the vegetable kingdom, admits of two modifications—the ring cells being in one case cut off from a *hemispherical*, and in the other from a *bell-shaped* mother cell. It is to be hoped that I may succeed, in other species better suited for the investigation than those hitherto examined by me, in tracing more accurately the process of septum-formation and the behaviour of the cell-nucleus during that process. Only then will it be possible to decide whether this new form of cell-formation ranges itself immediately beside that previously observed, or whether it is essentially different therefrom.

EXPLANATION OF PLATE VI.

Fig. 1. Youngest observed developmental stage of a marginal antheridium of *Aneimia hirta*. The central cell possesses the form of a biconvex lens. (Drawn after treatment with caustic potash and muriatic acid.)

Fig. 2. A somewhat older state; the bell-shaped cell is still undivided: *a*, fresh; *b*, after the same treatment as fig. 1.

Fig. 3. Half-grown antheridium; the envelope is completely formed; in the central cell the first divisions are already produced: *a* & *b* as under fig. 2.

Fig. 4. A somewhat older state than fig. 3: *a* & *b* as under fig. 2.

Fig. 5. Mature antheridium. (It was evacuated during observation.)

Fig. 6. An antheridium just evacuated. (To the right the cell-nucleus of the ring cell is distinctly recognizable.)

Fig. 7. An antheridium which has long been evacuated, seen from above. The inner folded wall of the ring cell is already strongly embrowned; the cell-nucleus is no longer recognizable.

Fig. 8. Half-developed antheridium of *Ceratopteris thalictroides*, springing obliquely from a marginal cell of the prothallium. The envelope is completely formed; the central cell is divided crosswise into four cells. (Drawn after treatment with caustic potash and muriatic acid.)

Fig. 9. Two mature antheridia of the same species: *a*, with normal, unsymmetrical, *b*, with abnormal, symmetrical basal cell.

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* "Ueber die Entwickelung der Farrnkrautspaltöffnungen," Bot. Zeit. 1866, p. 245.

† "Ein Beitrag zur Entwickelungsgeschichte der Spaltöffnungen," Pringsheim's Jahrb. v. p. 309.

Fig. 10. Evacuated antheridium of the same species. A special mother cell has remained behind in the inner space.

Fig. 11. Rudimentary antheridium of *Asplenium alatum*. Only the lower ring cell is cut off. Its cell-nucleus lay to the left, and was distinct when the antheridium was generally in focus.

Fig. 12. Like the last.

Fig. 13. Somewhat later developmental state. The upper cell has divided into a shallow bell-shaped outer cell and the central cell: *a* & *b* as under fig. 2.

Fig. 14. The bell-shaped cell has already been divided into the second ring cell and the opercular cell; the central cell is still undivided. (After treatment with caustic potash and muriatic acid.)

Fig. 15. A somewhat older stage. The central cell is already divided into eight cells, of which only four are visible. (Treatment as under fig. 14.)

Fig. 16. Mature antheridium with three ring cells; the intermediate ring cell is set obliquely upon the inferior one, so that one side of the latter is excluded from the envelope of the special mother cells.

Fig. 17. Evacuated antheridium, with three ring cells, in each of which a spherical nucleus is distinctly visible.

Fig. 18. Young antheridium of *Cibotium Schidei*, seen from above. The central cell is broken up into four quadrants, of which two are already again divided; the operculum consists of two cells. (After treatment with caustic potash and muriatic acid.)

Fig. 19. Young antheridium, seen from the side. The central cell is still undivided. By a mistake of the lithographer, the circle in which the lower funnel-shaped septum applies itself to the outer wall is placed rather too low down.

All the figures are drawn with the camera, and magnified 325 diameters.

XXV.—*On Additions to the Coleopterous Fauna of the Cape-Verde Islands.* By T. Vernon Wollaston, M.A., F.L.S.

Fam. **Hydrophilidæ.**

Genus Philhydrus (Col. Hesp. p. 44).

My attention has lately been drawn by Dr. Sharp (who has studied the *Philhydri* with considerable care) to the fact that what I had hitherto regarded (on the authority, originally, of Aubé) as the *melanocephalus* of Olivier is *not* referable, in reality, to that insect. Moreover the *Cape-Verde* examples appear, in addition, to be separable into *two* species, both of which are distinct from the one (recorded by myself, equally, as the "*melanocephalus*") which is so universal in the Madeiran and Canarian archipelagos, and which Dr. Sharp is of opinion should be identified with the Mediterranean *P. politus* of Küster. These two Cape-Verde *Philhydri* he considered to be undescribed; and he has lately, therefore, at my own request, published diagnoses of them, which, however, much they may be related *inter se*, establish at all events the fact of their complete divergence from the *politus* of more northern latitudes; so that it would consequently appear that the true *melanocephalus*, although cited by myself for the Madeiran, Canarian, and Cape-Verde groups, has not yet been observed in *any* of them, the examples from the first and second archipelagos being referable to the *politus* of Küster, whilst those from the third contain *two* additional forms, of which (although recently enunciated by Dr. Sharp) it may perhaps be useful here to give the characters afresh. The species alluded to are as follows:—

Philhydrus Wollastoni.

P. subovalis, parum convexus, nitidus, niger (aut fusco-niger) sed in limbo gradatim dilutior, ubique crebre et subtiliter punctatus (punctis in elytris vix remotioribus); capite maculis duabus parvis lateralibus ante oculos, antennis (clava excepta), palpis tarsisque piceo-testaceis; pedibus piceis; coleopteris seriebus tribus irregularibus punctorum majorum utrinque longitudinaliter notatis.

Long. corp. lin. circa $2\frac{1}{2}$.

Philhydrus melanocephalus, Woll. [nec Oliv.], Col. Hesp. 44 (1867).
—— *Wollastoni*, Sharp, Ann. Nat. Hist. ser. 4. vol. v. p. 16 (1869).

Habitat ins. S. Antonio, S. Vicente, S. Iago, et Brava, a Dom. J. Gray et meipso captus.

Obs. Species *P. politum*, Küst. (in ins. Canariensibus Maderensibusque, necnon in Hispania regionibusque contiguis lectum) prima facie simulans, sed corpore minore, subbreviore, vix minus nitido et vix minus convexo, interdum in elytris subdistinctius punctulato, prothorace subbreviore, palpis tarsisque gracilioribus, necnon unguiculis (in utroque sexu vix diversis) minoribus denticuloque minore subtus armatis dignoscitur.

This is apparently the common *Philhydrus* of the Cape-Verde archipelago; and we may expect that it will be found to be universal wherever there are streams and pools of sufficient importance not to be totally obliterated during the drier seasons. Having neglected, however, when compiling my 'Coleoptera Hesperidum,' to examine it with any great amount of care, I fell into the error of regarding it as a rather small state of the species which is so general throughout the Madeiran and Canarian groups; and since that species was identified by Aubé, many years ago, with the European *melanocephalus*, I have invariably cited it as such, and consequently looked upon this representative from the Cape Verdes as a mere depauperated phasis of the same. Yet the recent labours of Dr. Sharp have shown, as above mentioned, not only that I was mistaken in accepting too readily the determination of Aubé as regards the Madeiran and Canarian *Philhydrus*, but likewise that the Cape-Verde examples are specifically distinct from those of the more northern archipelagos (which seem to be the *politus*, Küst.).

The present *Philhydrus* is decidedly more abundant than the following one, having been found by Mr. Gray and myself in the islands of S. Antonio, S. Vicente, S. Iago, and Brava, in the first of which it was met with likewise by Dr. H. Dohrn. It is rather smaller, and just appreciably shorter, than the *P. politus* of more northern latitudes, its prothorax is (if any thing) a trifle more abbreviated, and its palpi and feet are slenderer,—the latter, moreover (which differ but slightly in the two sexes), having their claws considerably less developed, and armed at the inner base with a less conspicuous denticle.

In his remarks on the Atlantic species of *Philhydrus*, Dr. Sharp observes that the *P. Wollastoni* is "nearly as large as the northern *P. melanocephalus*, but is darker and more uniform in colour, with its elytra sparingly and much more indistinctly punctured, and with the claws of its tarsi much smaller and scarcely differing in structure in the two sexes,—in which last respect it resembles the *P. ovalis*, Th., and *marginellus*, Fab., and differs decidedly from *P. politus*, Küst., and *maritimus*, Th."

Philhydrus hesperidum.

P. oblongo-ovalis, minus convexus, nitidus, ubique leviter et subtiliter punctulatus (punctis in elytris sensim remotioribus ac subobsoletis); capite nigro, maculis duabus parvis lateralibus ante oculos, antennis (clava excepta), palpis (apice ipsissimo excepto) tarsisque testaceis; pedibus piceis; prothorace brevi, in disco fusco-nigro, marginibus (præsertim lateralibus) lurido-testaceis; coleopteris lurido-testaceis, in disco plus minus obscurioribus (rarius nigrescentibus), seriebus tribus irregularibus punctorum majorum notatis.

Long. corp. lin. $1\frac{1}{2}$–2.

Philhydrus melanocephalus (pars), Woll. [nec Oliv.], Col. Hesp. 44 (1867).

—— *hesperidum*, Sharp, Ann. N. H. ser. 4. vol. v. p. 16 (1869).

Habitat S. Antonio, S. Vicente, S. Iago, et Brava, in locis similibus ac præcedens sed rarior.

Obs. Speciei præcedenti affinis sed (ut a cl. Sharp dicitur, et mihi videtur) certe distinctus. Differt corpore minore, minus convexo, et paulo magis oblongo, punctura (saltem in elytris) subtiliore obsoletiore, prothorace sensim breviore, marginibus evidentius dilutioribus, elytris minus nigris (interdum fere lurido-testaceis), palpisque ad apicem ipsissimum infuscatis.

Apparently scarcer than the *P. Wollastoni*, but captured by Mr. Gray and myself in S. Antonio, S. Vicente, S. Iago, and Brava. It is smaller and less convex than that species, and relatively a little narrower and more oblong; its prothorax is just appreciably shorter and more distinctly pale at the margins (not only laterally but, narrowly so, even before and behind); its elytra are less black (being often scarcely more than a lurid testaceous brown even on the disk), and rather more finely and obsoletely punctulated; and the *extreme* tips of its palpi are usually infuscate.

Dr. Sharp, in alluding to this *Philhydrus*, remarks that it is closely allied in form and appearance to the European *P. marginellus*, but that it is not quite so large as that species, and that it is at once distinguishable from it by, *inter alia*, its very sparingly and obsoletely punctured elytra.

Fam. **Coccinellidæ.**

Genus Scymnus (Col. Hesp. p. 159).

After *S. floricola* and immediately before *S. fractus* (p. 163), insert the following:—

Scymnus conjunctus, n. sp.

S. ovalis, niger, subnitidus, grosse, longe et vix demisse cinereo-pubescens; prothorace subconcolori (aut ad latera vix dilutiore), minute punctato, basi in medio leviter sinuato; elytris paulo densius ac multo distinctius punctatis, singulis ad apicem macula subluniformi (in disco postico sita), altera ovali longitudinali (intra discum posita), et tertia (longe ante humerum terminata, necnon in subluniformem postmediam longitudinaliter recte coëunte), rufo-testaceis ornatis; pedibus saturate testaceis.

Long. corp. lin. 1.

Habitat ins. S. Vicente, a Dom. Gray semel deprehensus.

The present *Scymnus*, in its general aspect and coloration, and much enlarged eyes, belongs to the same type as the *fractus*, *picturatus*, &c. of the Cape-Verde archipelago, as well as the Canarian *maculosus* and the Madeiran *flavopictus*; but, judging from the single example now before me, it appears to be a trifle larger than any of them, as well as a little less shining and much more strongly punctured. From the *fractus* and *picturatus* (with which alone it could be confounded in the Cape-Verde fauna) it may further be known by its prothorax being somewhat broader and more sinuated at the base, and by the subhumeral patch on each of its elytra being confluent laterally with the exterior curve of the subapical (or postmedial) lunate one. The specimen from which my diagnosis has been drawn out was taken by Mr. Gray in the island of S. Vicente, and was overlooked by myself (when compiling the 'Coleoptera Hesperidum') from the fact of its being mixed up, at the time, in a small tube, with various common forms which had been given to me by Mr. Gray.

Fam. Scauridæ.

Genus Scaurus (Col. Hesp. p. 178).

Scaurus variolosus.

Mr. G. R. Crotch has recently informed me that he believes this *Scaurus* to be identical with the European *S. punctatus.* Although it is quite possible that it may in reality be but a geographical modification of that species, I cannot but think that the much less powerfully developed processes, even in the males, of its anterior femora and tibiæ (the *hinder* tooth of the former being reduced to a mere anguliform prominence, whilst that on the posterior edge of the latter is almost obsolete —indeed, completely so in the opposite sex) is sufficient, apart from its rather smaller size and its somewhat more deeply and sharply punctured surface, to separate it from its Mediterranean ally. Nevertheless it is clear that *S. punctatus* is the species which it the most nearly resembles; and naturalists must therefore judge for themselves whether or not they feel bound to regard it as a southern and altered phasis of that insect.

Fam. Tenebrionidæ.

Genus Tenebrio, Linn.

Tenebrio Paivæ, n. sp.

T. subcylindricus, crassus, niger, subopacus, ubique densissime arguteque punctatus; prothorace transverso, basi fortiter bisinuato, ad latera (æqualiter facile rotundata) et basin tenuiter marginato, subæquali (i. e. ad basin ipsam nec transversim impresso, nec bifoveolato); mesosterno triangulariter concavo (lobum prosternalem crassum recipiente), scutello magno transverso subpentagono-triangulari; metasterno breviusculo; elytris ad basin valde sinuatis, vix omnino parallelis (sc. pone medium plerumque obsolete sublatioribus), nec solum punctis ubique obsitis sed argute substriato-punctatis punctisque perpaucis majoribus præcipue in interstitiis alternis parcissime irroratis; antennis pedibusque longiusculis robustis et dense punctatis, illarum art^{o} 3^{tio} elongato, reliquis obsolete subserratis (i. e. intus apice subproductis), ult^{mo} penultimo sensim longiore, tarsorum posteriorum art^{o} basali elongato.

Mas tibiis (præsertim posterioribus) subarcuatis, necnon intus tuberculis subdenticuliformibus remotis parce armatis.

Long. corp. lin. 6–9.

Habitat ins. Fogo, a cl. Barone Castello de Paiva nuper communicatus.

Several examples of this large *Tenebrio* have been communicated by the Barão do Castello de Paiva, by whom they were received from the island of Fogo*; and it gives me great pleasure to name the species after a naturalist so eminent, and from whose liberality I have at various times derived much valuable assistance in elucidating the Coleopterous fauna of these immediate Atlantic groups. It is remarkable for its rather large size, thickened body, and nearly opaque, densely punctured surface—the elytra being, in addition, sharply substriate-punctate, and having a few *larger* punctures scattered sparingly down each alternate interstice. As compared with the *T. molitor* and *obscurus*, of more northern latitudes, it may be said to be relatively a little broader and not *quite* so strictly parallel (the elytra having generally a slight tendency to be just appreciably dilated behind the middle), with its prothorax (which is neither transversely impressed, nor bifoveolated, posteriorly) and its elytra more deeply sinuate at their respective bases, and with its limbs longer—the third and apical joints of the antennæ (which are gradually subserrated internally, towards their apex), and the first one of the four hinder feet, being, more particularly, lengthened. Its sexual characters are somewhat peculiar,—the male tibiæ (especially the four *hinder* ones) being very gently curved, and sparingly armed along their inner edge with minute, distant, tuberculiform denticles. In the large size of its transverse scutellum it has more in common with *T. molitor* than with *T. obscurus*.

Such are the three additions which have lately been made to the Coleopterous fauna of the Cape Verdes—raising the number of species which have hitherto been brought to light in that barren archipelago from 278 to 281. The fact, also, of the *Carpophilus mutilatus* (which was taken most abundantly by Mr. Gray and myself in S. Antonio and S. Iago) being included amongst some *S.-Vicente* insects which have been given to me by Mr. Gray, and of the *Diplognatha gagates* (of which I obtained a single example in Brava) having been communicated by the Barão do Castello de Paiva, from *Fogo*, will augment the *local* lists of those two particular islands—already increased, each of them, by one, through the new

* I have no information as to the precise circumstances under which the *Tenebrio Paivæ* was found; but there are many examples of it, mixed up with the following fourteen species, all of which (with the exception of the *Diplognatha gagates*, which I met with in Brava only) I myself captured in the low and intermediate districts of Fogo:—*Calosoma senegalense* and *tegulatum*, *Masoreus spinipes*, *Chlænius uncosignatus*, *Diplognatha gagates*, *Coccinella 7-punctata*, *Hegeter tristis*, *Oxycara similis*, *Scaurus variolosus*, *Melanocoma vestita*, *Trichosternum granulosum*, and *Opatrum patruele*, *clavipes*, and *hispidum*.

Scymnus compunctus from the former, and the *Tenebrio Paivæ* from the latter. And when we likewise include an additional *Philhydrus* for S. Antonio, S. Vicente, S. Iago, and Brava, the exact numbers (as hitherto ascertained) for the respective *island*-catalogues will stand as follows:—

S. Antonio	115	S. Iago......	129
S. Vicente......	134	Fogo........	95
S. Nicolão......	27	Brava	62

XXVI.—*Notes on the Structure of the* Crinoidea, Cystidea, *and* Blastoidea. By E. Billings, F.G.S., Palæontologist of the Geological Survey of Canada*.

1. *Position of the Mouth in relation to the Ambulacral System.*

The earlier palæontologists, Gyllenhal, Wahlenberg, Pander, Hisinger, and others, described the large lateral aperture in the Cystidea as the mouth, apparently on account of its resemblance to the five-jawed oral apparatus of the sea-urchins. In his famous monograph, 'Ueber Cystideen,' 1845, Leopold von Buch advocated the view that it was not the mouth, but an ovarian aperture, and that the smaller orifice usually situated in the apex, from which the ambulacral grooves radiate, was the true oral orifice. These opinions were adopted by Prof. E. Forbes in his memoir on the British Cystidea, by Prof. J. Hall in the 'Palæontology of New York,' and by most others who have described these fossils, including myself, in my first paper on the Cystidea of Canada, published in the 'Canadian Journal' in 1854. In 1858 I re-investigated the subject while preparing my Decade No. 3, and came to the conclusions that the lateral aperture was the mouth in those species which were provided with a separate anus, and that in all others it was both mouth and anus. The small apical orifice I described as an ambula-

* From Silliman's American Journal of Science, July 1869.

"This paper was prepared for the press last December; but as my collection of the Blastoidea was small, I thought it best to delay publication until I could examine a greater number of specimens. In January I applied to S. S. Lyon, Esq., of Jeffersonville, Indiana, and he replied that, if I would let him know what points I wished to investigate, he would supply me with the materials. On my giving him the desired information, he, in the most liberal manner, sent me a large collection (much larger than I expected to receive), consisting of numerous specimens of several genera, many of them in the state of preservation best adapted for investigation—some of them empty and others silicified in a matrix of limestone. Prof. E. J. Chapman (Professor of Geology and Mineralogy, Univ. Coll. Toronto) also kindly supplied me with several Russian Cystideans. To both of these gentlemen I here tender my thanks."—E. B.

cral aperture. According to these views, the mouth of a Cystidean does not stand in the centre of the radial system, as it does in all the existing Echinodermata. On this point Prof. Wyville Thomson has the following observations:—

"I can see no probability whatever in the opinion lately advocated by Mr. Billings, and which has received some vague support from the writings of De Koninck and others, that the 'pyramid' in the Cystideans is the mouth, and that the aperture whence the ambulacra radiate is simply an 'ambulacral orifice.' Such an idea appears to me to be contrary to every analogy in the class. There can be no doubt of the existence of distinct openings for the passage of the ambulacral nerves and vessels from the calyx of many of the palæozoic crinoids; but I think we must certainly assume that in this, as in all other known instances, these vessels had their origin in an annular vessel surrounding the mouth. In the whole class the œsophageal circular canal seems to be the origin and centre of the ambulacral system. It is the first part which makes its appearance in the embryo, and is so permanent and universal that one could scarcely imagine a radiating ambulacral vessel rising from any other source. The early origin of this important vascular centre, in this annular form and in this position, evidently depends upon, and is closely connected with, the origin of the nervous system in the œsophageal nerve-ring, constant in the whole Invertebrate series"*.

With all due deference, I cannot admit that we must assume that, in the Cystidea, the ambulacral tubes had their origin in "an annular vessel surrounding the mouth." It is true that such a vessel does surround the mouth of existing Echinodermata; but there is no essential or direct physiological connexion between the two organs. Their functions are exercised independently of each other. There is no organ issuing out of the alimentary canal that communicates with the annular vessel. This latter might be situated in any other part of the body, and still perform its functions, provided there were a connexion between it and the ambulacra. In this class the position of the various organs in relation to each other, and also to the general mass of the body, is subject to very great fluctuations. Thus the mouth and vent are separated in some of the groups, but united in others, while either or both may open out to the surface directly upward or downward, or at any lateral point. The ovaries may be either dorsal or ventral, internal or external, and associated with either the mouth, or the anus, or with neither. The ambulacral skeleton may be

* Edinburgh New Phil. Journal, vol. xiii. p. 112 (1861).

imbedded in and form a portion of the general covering of the body, or lie upon the surface, or be borne upon free-moving arms. In genera belonging to the same family these relations are constant or nearly so, but are found to be extremely variable when different orders or remotely allied families are compared.

While preparing my Decade No. 3, I investigated this subject, and satisfied myself that in at least a large proportion of the palæozoic Crinoids the mouth was disconnected altogether from the radial system. A great many species might be referred to in which we can see both the centre from which the ambulacra proceed, and the mouth, and at the same time see that they are not in the same place. A long train of reasoning is not necessary, only simple inspection. It will be quite sufficient to notice a few of these species to prove that the rule laid down by Prof. Wyville Thomson is not a general rule.

Fig. 1.

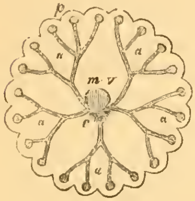

Fig. 2.

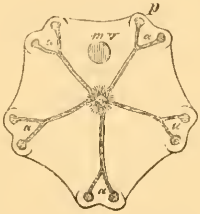

Fig. 3.

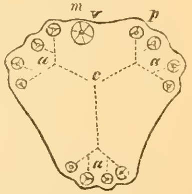

Fig. 1. This figure is a diagram of the interior of the vault of a Crinoid which appears to be *Batocrinus icosidactylus* (Cassiday), a fossil that occurs in the Carboniferous rocks of Kentucky. It was sent to me by Mr. S. S. Lyon, of Jeffersonville, Indiana, several years ago. The test is in a beautiful state of preservation, and perfectly empty, so that all of the markings on the inner surface can be distinctly seen. There are twenty-one arms arranged in five groups (*a*), and the same number of ambulacral openings (*p*), each just large enough to admit of the entrance of a slender pin. The mouth (*mv*) is nearly central; and close to it, on the posterior side, there is a small rudely pentagonal space (*c*) with no markings except several small tubercles. The grooves are scarcely at all impressed; and, indeed, I think they are never so in any Crinoid, except in those which have a thick test. In this specimen their course is clearly indicated by the remains of the thin partitions which either separated them or to which the vessels were attached. They do not run directly toward the mouth, as

they would do if that organ were the centre of the ambulacral system, but to the small space (*c*) behind it, where there appears to have been situated a vesicle or some other apparatus, to which all of them were united. Whatever may have been the structure of this central organ, from which the five main grooves radiate, it no doubt represented the annular vessel of the recent Echinodermata to which Prof. Thomson alludes.

Fig. 2 represents the structure of an *Amphoracrinus* from the Carboniferous rocks of Ireland (precise locality and species not determined). There are ten arms; the test is very thick; the ambulacral channels converge to the central point, but do not quite reach it; the mouth (*mv*) is about halfway between the centre and the margin. In this Crinoid it is perfectly impossible that the mouth can be the centre of the radial system, because the two anterior passages, between which it is situated, are for their whole length tunnelled, as it were, through the substance of the plates, and only penetrate downward into the interior at the central space.

Fig. 3 is a plan of the summit of the widely known and remarkable fossil *Caryocrinus ornatus* (Say). In this species there are only three, instead of five, groups of arms. In large individuals there are from twelve to twenty free arms (but always arranged in the three groups), with a small pore at the base of each. This pore is about the size of the ovarian pore of an *Echinus*, and can only be seen in well-preserved and clean specimens. The ambulacral grooves have not yet been observed, but their course is indicated by three low rounded ridges, which may be seen, in some specimens, radiating from a large heptagonal plate situated at *c*. The mouth (*mv*) is valvular, composed of from five to eight or ten plates, and is always situated near the margin between the two anterior groups of arms. With the exception of the ambulacral pores, there is positively no other aperture in the summit of *Caryocrinus*. If it be true that the mouth of an Echinoderm must be always situated in the radial centre, then *Caryocrinus* and also nearly all the palæozoic genera were destitute of that aperture.

Caryocrinus is a genus which seems to form a connecting link between the Crinoidea and the Cystoidea. By examining numerous well-polished sections, I find that the structure of the respiratory areas is the same (in general plan) as that of the genera *Glyptocystites*, *Pleurocystites*, and *Echinoencrinites*, as will be shown further on. The arms are also arranged in three groups, as in *Sphæronites* and *Hemicosmites*, while the mouth is valvular. On the other hand, the long cylindrical column and the arrangement of the arms around the margin, with the ambulacral pores at their bases, are Crinoidal characters.

In addition to the above, the following species may be referred to as examples of Crinoids with the mouth separate from the centre of the radial system:—

Amphoracrinus tessellatus (Phillips). Figured by J. Rofe, Esq., Geol. Mag. vol. ii. p. 8, fig. 3. The figure represents a cast of the interior of the vault, showing the five ambulacral grooves in relief. The mouth is situated in the angle between the two anterior grooves.

Strotocrinus perumbrosus (Hall, sp.). Figured by Meek and Worthen in the 'Geology of Illinois,' vol. ii. p. 188, f. 5. The specimen is 13 lines in diameter, the ambulacral centre 13 lines from the anterior margin, and the mouth 11 lines*.

Glyptocrinus armosus (M'Chesney, sp.). This extraordinary Crinoid is figured by M'Chesney in his 'New Pal. Foss.' pl. 7. f. 6, and also by Prof. Hall, in the 20th Reg. Rep. N. Y. pl. 10. f. 11. The specimens are between 2 and 3 inches in length. There are ten arms; the anterior side is much inflated; the proboscis appears to be large at its base and excentric in its position, but, instead of standing erect, it bends down to the surface of the vault, and lies upon it, crossing over to the posterior margin. Judging from the figures, the centre of the

* In April last I received from Messrs. Meek and Worthen a paper entitled "Notes on some points in the Structure and Habits of the Palæozoic Crinoidea." Of all the papers relating to this subject yet published on this continent, this one (at least, so it appears to me) is the most interesting and important. It is written with a clearness and particularity rarely to be seen in palæontological memoirs. In some respects it confirms the opinions advocated in these notes, but bears directly against my views on the question here under discussion, *i. e.* "the position of the mouth with relation to the radial centre." As I wish to give the remarkable observations of the authors full consideration, I shall not discuss them now, but delay until the September No. of this Journal. [Meek and Worthen's paper is given in Silliman's Journal, July 1869, p. 23.] I shall only state here that I believe that the grooves on the ventral disk of *Cyathocrinus*, and also the internal "*convoluted plate*" of the palæozoic Crinoids, with the tubes radiating therefrom, belong to the respiratory and perhaps, in part, to the circulatory systems—not to the digestive system, as is supposed by the authors. The convoluted plate, with its thickened border, seems to foreshadow the "œsophageal circular canal," with a pendent madreporic apparatus as in the Holothuridea. To me the final determination of this question is of much importance; for if Meek and Worthen are right, then I must be wrong so far as regards nearly all that I have published with reference to the functions of the apertures of the palæozoic Echinodermata. It is fortunate that the solution of this curious problem is now undertaken by men who have access to the magnificent cabinets of the geologists of the western States, and also by men who habitually discuss scientific subjects with the sole object in view of arriving at the truth.

base of this organ must be distant from the radial centre at least one-fourth of the whole width of the vault. *G. siphonatus* (Hall), figured on the same plate, shows that the anterior grooves curve round to the posterior side of the proboscis, as they do in *B. icosidactylus* above cited.

I should also state here that, two or three years ago, Mr. Meek, to whom I had written for information on this subject, wrote me that in all cases where he had observed the grooves on the interior of the vault, they radiated, not from the mouth, but from a point "in front of it." (This would not be in front of, but behind, the mouth, according to the terminology used in these notes. I think that the side in which the mouth is situated should be called "anterior" or "oral," even although both the mouth and anus should be included in it.)

In all the species above cited, the figures (with the exception of that of *C. ornatus*) exhibit the relative position of the mouth and radial centre as it has been actually seen in casts of the interior of the vault. But, besides these, numerous examples may be found in the works of Miller, Austin, De Koninck, Phillips, Meek, Worthen, Shumard, Hall, Lyon, Cassiday, and others, of Crinoids whose external characters show that, in them, the mouth cannot be in the central point from which the grooves radiate.

With respect to Prof. Thomson's theory, I freely admit that, if it is true that in all the Echinodermata, fossil and recent, the mouth is the radial centre, then that aperture must be the one which I call the ambulacral orifice in the Cystidea. The views, however, advocated by me in my Decade No. 3 appear to be gradually gaining ground. As these fossils are rare, few have occasion to study them; and consequently the subject has not been much discussed since 1858, the date of the publication of that work. The following are the only authors, so far as I have ascertained, who have given their opinions on this vexed question during the last eleven years:—

Prof. Wyville Thomson, *op. cit.* p. 111 (1861), agrees with me that the lateral aperture is not an ovarian orifice, but, as we have seen, is strongly opposed to the view that it is the mouth. He calls it the anus.

Prof. Dana (Man. Geol. p. 162, 1863) recognizes it as the homologue of the simple aperture (oral and anal) in the summit of those Crinoids which have but one. This is exactly my view. [J. W. Salter agrees with Prof. Thomson that it is the anus, not the ovarian aperture (Mem. Geol. Sur. G. B. vol. iii. p. 286, 1866.) Prof. S. Lovén, of Stockholm, has described, in the 'Proceedings of the Royal Swedish Academy,' 1867, the remarkable sea-urchin, *Leskia mirabilis* (Gray), which has the mouth constructed on the same plan as that of the Cystidea—that is to say, with five triangular valve-like plates, which are immediately attached to the interambulacral plates, without the intervention of a buccal membrane. After comparing this structure with the valvular orifice of *Sphæronites pomum* (Gyll.), he says :—" that the ' pyramid,' which in *Leskia* is the armature and covering of the mouth, is the same thing in the Cystidea is now quite certain; in the last-named group it was, doubtless, also the vent. The mouth does not lie where J. Müller and Volborth sought for it, viz. in the centre of the ambulacral furrows; and the organ interpreted as the vent by Volborth and Von Buch, is more correctly regarded as an external sexual organ." (Geol. Mag. vol. v. p. 181, Dr. Lütken's transl.)]

2. *On the Pectinated Rhombs and Calycine Pores of the* Cystidea.

None of the organs of the Echinodermata have been the subject of so much speculation as the calycine pores and the so-called " pectinated rhombs " of the Cystidea. Their relations and function long remained in doubt; but there seems to be now sufficient data to show that they are respiratory organs, and also that they are the homologues of the tubular apparatus which underlies the ambulacra of the Blastoidea. J. Müller suggested a comparison between these peculiar organs and the respiratory pores of the Asteridæ (Ueber den Bau der Echinodermen, p. 63, 1854). Prof. Huxley has placed them in the same relation (Medical Times, Dec. 1856). Eichwald calls them respiratory pores (Lethæa Rossica, vol. i. p. 614: 1860). Prof. Dana says " they are probably connected with an aquiferous system and respiration " (Man. Geol. p.162 : 1863). Mr. Rofe, after showing that their structure is the same as that of the striated surfaces between the rays of *Codaster*, says, " From the construction of these striations on the face of *Codaster*, and on the ' pectinated rhombs ' of the Cystidea, may we without assumption suggest the possibility of their being respiratory sacs, lined with cilia, and constructed of a porous test, through which air from the water could pass by diffusion" (Geol. Mag. vol. ii. 251 : 1865). As for myself, when I prepared my Decade on the Cystidea, I gave this subject a great deal of consideration, and studied a large number of specimens, but could arrive at no conclusion satisfactory to myself. I am now convinced that the view of the above-named distinguished authors is the correct one. These are respiratory organs. In all the species in which they occur they seem to be constructed on the same general plan, *i. e.*

the interposition of an exceedingly thin partition between the circumambient water and the fluid within the general cavity of the body. They are usually of a rhomboidal shape, each rhomb being divided into two triangles by the suture (*c c*, figs. 4, 5) between two of the plates. In several of the genera the two halves of the hydrospires are reniform, ovate, or lunate, and either internal or external.

Fig. 4.

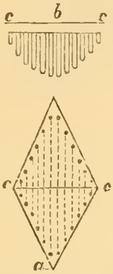

Fig. 5.

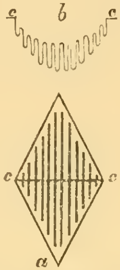

Fig. 6.

Fig. 7.

Fig. 4. Hydrospire of *Caryocrinus ornatus*: *a*, surface view, the dots around the margin are the spiracles, the small dotted lines represent the course of the flat internal canals; *c c*, suture between the two plates; *b*, transverse section. Fig. 5. Hydrospire of *Pleurocystites*: *a*, surface view; *c c*, suture; *b*, transverse section. Fig. 6. The same, with the points *c c* drawn together. Fig. 7. Internal gill of a spider.

In order to avoid the use of double terms, I propose to call them "*hydrospires*," and their apertures "*pores*," "*fissures*," or "*spiracles*," according to their form.

In *Caryocrinus ornatus* the hydrospires (fig. 4) are of a rhomboidal form, and have each of the four sides bordered by a single row of small tubercles. Some of these tubercles have a single pore in the summit, while others are perforated with a variable number—from two to twenty, or perhaps more, thus becoming vesicular or spongy. It is only the apex of the tubercle, however, that has this structure; for when this is worn off, there is only a single pore to be seen. The pores penetrate through the plates, but do not communicate directly with the general cavity of the body. Internally each hydrospire consists of a number of flat tubes arranged parallel to each other and lying side by side, in the direction of the dotted lines in fig. 4 *a*. Each tube receives two of the pores seen on the exterior—one pore at each end. These tubes are composed of a very thin shelly membrane, which, although possessed of sufficient rigidity to maintain its form, was, no doubt, of such a minutely porous texture as to admit of the transfusion of fluids in both directions—outward and inward.

In a large hydrospire there are about twenty of those tubes; their greatest breadth is at their mid-length, where they are crossed by the suture (*c c*); and as they become narrower accordingly as their length decreases, the one in the middle projects the deepest into the perivisceral cavity. In consequence of this arrangement, when a section is made across the hydrospire at the suture, *c c*, fig. 4 *a*, the form *b* is obtained, where *c c* is the surface of the shell, while the comb-like structure below represents the tubes.

Specimens of *C. ornatus* almost entirely empty are often found; and in some of these the internal form of the hydrospires is sometimes preserved. Those that I have seen have the form of small rhomboidal pyramids, with four slightly convex sloping faces, and composed of a number of vertical parallel plates (the casts of the interior of the tubes), the substance of the tube itself not being preserved. I have, however, several polished transverse sections in which I think the thin walls can be seen.

The structure of the hydrospires is such that there can scarcely be any doubt that they are respiratory organs. The sea-water entered through the pores, and aërated the chylaqueous fluid contained in the perivisceral cavity by transfusion through the exceedingly thin membranous shell that composed the walls of the tubes. The number of pores varies with the size of the individual. In large specimens there are from 800 to 1000.

It has been stated by some authors that the pores were passages for the protrusion of internal organs connected with the vitality of the animal. The fact, however, that the pores do not penetrate into the general cavity of the body disproves this theory; and, moreover, through many of the tubercles (those with a vesicular and spongy summit) such protrusion would be utterly impossible.

In *Caryocrinus ornatus* there are thirty hydrospires, arranged as follows:—

1. Ten at the base—half of each on a basal plate and the other half on one of the subradials, their longer diagonal vertical.

2. A zone of six around the fossil at the mid-height, their longer diagonals horizontal. These seem to be imperfectly developed; for, on the inside, the tubes occupy only a small space in the centre.

3. A third band, of fourteen—two of them with their longer diagonals vertical, and the others arranged in six pairs, the diagonals of each pair inclining toward each other upward at an angle of about 30°. There are only three interradii in

Caryocrinus; the mouth is placed in one of them, and the two hydrospires with vertical diagonals in the other two.

In *Pleurocystites* the hydrospires are also of a rhomboidal form; but, instead of having the tubular structure of *Caryocrinus*, they consist of a number of parallel inward folds of an exceedingly thin part of the shell. These folds, no doubt, represent the tubes of *Caryocrinus*. If we grind down a hydrospire of this latter, so as to remove all the shell, and expose the edges of the tubes, it then presents precisely the same form as fig. 5 *a* (*i. e.* the form of a rhomb longitudinally striated at right angles to the suture, and with no pores). The transverse section in *Pleurocystites* only differs from that in *Caryocrinus* in having no shell between the points *c c*. In the hydrospire of *Pleurocystites robustus*, of the Trenton Limestone, we have the commencement of the formation of an internal gill with a single spiracle. The surface is not flat, as it is in many species, but concave, as shown in the section; and it is evident that if the concavity were carried further, and at the same time the points *c c* made to approach each other, the effect would be to produce an elongated sac, deeply folded on one side, and with a fissure extending the whole length on the other side. The transverse section of such a sac would be fig. 6, the same as in *Pentremites*. Again, if we contracted the four sides, gradually curving them outward at the same time, but not diminishing the superficial extent of the walls of the folds, although altering the form to correspond with the decreasing aperture, the result would be a deeply folded flask-shaped sac, with a small round orifice like fig. 7, which is the internal gill of a spider.

In *Palæocystites tenuiradiatus*, a species very characteristic of the Chazy Limestone, the whole surface (in the condition in which the fossil is usually found) is covered with deeply striated rhombs, the fissures being deepest where they cross the suture, and growing gradually shallower as they approach the centre of the plates, where they die out altogether. Detached plates occur in vast abundance, but no perfect specimens have ever been found. I discovered, however, several fragments of the body sufficient to give the general form and to show that, when the surface is perfect, all these fissures are completely covered over by a very thin shell, and that when they cross the suture, there is a small pore in the bottom of each which penetrates to the interior. The rhombs of this species are thus external hydrospires. The fissures seen in the ordinary weathered specimens are the remains of flat tubes like those of *Caryocrinus*, situated on the outer instead of the inner surface of the test. The chylaqueous fluid passed outward through the pores and filled the tubes, to be aërated through the thin external covering by the surrounding water. In *Caryocrinus* the water passed inward, through the pores, into the tubes, and aërated the fluid within the general cavity of the body.

The discovery that the fissures and pores of the Cystidea do not communicate directly with the general cavity of the body is entirely due to Mr. Rofe. After reading his highly important paper, I re-examined a great number of specimens, and found sufficient to confirm his observations.

3. *On the Genus* Codaster.

Every author who has described a species of this genus has remarked the peculiar striated areas in the interradial spaces. Prof. M'Coy, the founder of the genus, pointed out their resemblance to the hydrospires of the Cystidea; but it was Mr. Rofe who first showed that they were also identical in structure therewith. On comparing one of these with that of the Cystidean *Pleurocystites* (fig. 5), we at once perceive that they are the same in external form, while Mr. Rofe's figures show that the section at *d d* (fig. 8) has the structure of fig. 9, which only differs from fig. 5 *b* in being straight above instead of concave, and in being divided into two parts. This division is the result of the position of the arm, which cuts the hydrospire in two in a direction parallel to the fissures. By drawing the points *d a* and *a d* together, we get figure 10, which is, in general plan, a section across one of the ambulacra of a Pentremite. On examining nearly all the published figures of species of this genus, I find that there is a series of forms which exhibit a gradual passage, from those with the hydrospires almost entirely exposed (as in fig. 8), through others, in

Fig. 8.

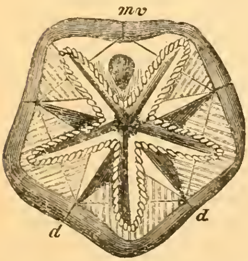

Fig. 9.

Fig. 10.

Fig. 11.

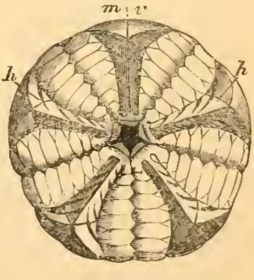

Fig. 8. Summit of *C. acutus*, M'Coy: *m v*, mouth and vent; *d d*, suture across the posterior hydrospire. Fig. 9. Section across the hydrospire from *d* to *d*; at *a* is the place of the arm. Fig. 10. The section contracted as in fig. 6. Fig. 11. Summit of *Pentremites caryophyllatus*, De Koninck.

which they are crowded more and more under the arms, until at length they become altogether internal.

In *C. acutus* (fig. 8) only a small portion of the hydrospire is concealed under the arm. In *C. canadensis*, a new species lately discovered in the shales of the Hamilton group in Canada West, each of the four interradial spaces in which the hydrospires are placed is excavated in such a manner as to form *a small triangular pyramid*, with two of its faces sloping down toward the sides of the two adjacent arms. On these two slopes are placed the hydrospires, which appear to have one fissure entirely under and another partly under the arm, five others being fully exposed. S. S. Lyon has described a species under the name of *C. alternatus*, in the 'Geology of Kentucky,' vol. iii. p. 494, from the Devonian rocks of that State, which closely resembles *C. canadensis*, but is still distinct therefrom. Speaking of the structure of the summit, he says:—"The depressed triangular intervening spaces are filled with seven or more thin pieces, lying parallel to the pseudambulacral fields, articulating with the summit of the second radial, and the prominent ridge lying between the pseudambulacra. These pieces were evidently capable of being compressed or depressed: the '*point*' at the lateral junction of the second radials is in some specimens folded over toward the mouth, so as to entirely obscure these triangular spaces by covering them." This important observation proves that even in the same species the hydrospires may be either partly or wholly concealed under the arm. The "*point*" to which Mr. Lyon alludes is seen above, in fig. 11, just below the letter *h*; it is the same as the "*small triangular pyramid*" in *C. canadensis*. It is evident that (supposing the shell to be flexible), if these points were to be drawn inward, the movement would gradually cause what remains exposed of the hydrospire to be covered, until at length it would be entirely concealed under the arm. The five points would then be situated in the angles between the five ambulacra, as they are in the genus *Pentremites* (fig. 15). The concealment of the hydrospires may also be the result of the widening of the arm. This is well shown in *P. caryophyllatus*, De Koninck (*P. Orbignyanus*, according to Roemer), *P. Schultzii*, DeVern., and several other species. In these the apices of the pyramids remain near the margin; but the hydrospires are nearly covered by the wide arms. This is shown in fig. 11, where the ends of the fissures of the hydrospires are seen along the sides of the angular ridges which extend from the apices of the pyramids to the angles between the arms. I do not think that such species can be referred to *Pentremites*; and if I had specimens before me instead of figures only, I should most probably institute a new genus for their reception.

Our specimens of *C. canadensis* are well preserved, and show the characters of the arms perfectly. After many careful examinations under the microscope, I can state positively that in this species the so-called "pseudambulacral fields" have no pores. The markings that have hitherto been mistaken for ambulacral pores in *Codaster* are not pores, but the small pits or sockets which received the bases of the pinnulæ. The rays therefore in this genus are not "pseudambulacral fields," in the sense in which that term is used in descriptions of species of *Pentremites*, but simply recumbent arms, identical in structure with those of the Cystidean genera *Glyptocystites*, *Callocystites*, *Apiocystites*, and others. They lie upon the surface of the plates which constitute the shell of the animals—not imbedded in them, as in *Pentremites*. The large lateral aperture is both mouth and vent, and the central opening heretofore called the mouth is the ambulacral or, more properly, the ovarian orifice. As therefore *Codaster* has the arms of *Apiocystites*, the hydrospires of *Pleurocystites*, and the confluent mouth and vent common to all Cystideans, I propose to remove it from the Blastoidea and place it in the order Cystidea.

4. *On the Genus* PENTREMITES.

In *Pentremites* the hydrospire is an elongated internal sac, one side of which is attached to the inside of the shell, while the side opposite, or toward the central axis of the visceral cavity, is more or less deeply folded longitudinally. There are two of these to each ambulacrum, attached along the two lines of pores. There appears to be a fissure extending nearly the whole length in the direction of the dotted line *f* (fig. 12). One edge of this fissure is attached to the lancet plate, along one side of the line of pores, the other to the shell, on the other side of the row. The pores all enter the hydrospire through this fissure. There are ten hydrospires, connected together in pairs, each pair communicating with the exterior through a single spiracle. The arrangement of the folds varies according to the species. In *P. Godoni* there are five folds, the outer sides of which are close up to the inner side of the lancet plate (fig. 13). In a specimen of *P. obesus*, Lyon, nearly two inches in diameter at the mid-height, the hydrospires extend inward about three lines, the main body being about one line from the lancet plate. There are five folds, each two lines deep; and thus, if the thin shelly membrane which constitutes the wall of the hydrospire were spread out, it would have a width of twenty-two lines; and the ten together would form a riband about eighteen inches in length and nearly two inches wide. The object of the folding is, of course, to confine this large amount of surface to a small space—an arrangement which at once proves the function to be respiratory. Of those figured by Mr. Rofe, *P. ellipticus*, Sowerby, appears to have only one fold; *P. inflatus*, idem, shows eight folds in one and eleven in the other hydrospire of the same ambulacrum. Another specimen, figured by Mr. Rofe under the name of *P. florealis*, Say, has five folds situated at a distance from the inner surface of the lancet plate, as in *P. obesus*. From the form of the organ, I think that Mr. Rofe's specimen cannot be the species called *P. florealis* by Say.

If it be granted that these organs are respiratory in their function, then their five apertures should be called *spiracles*,

Fig. 12.

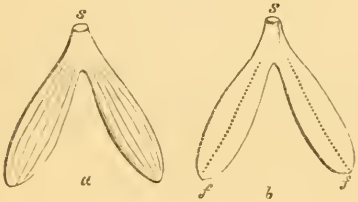

Fig. 13.

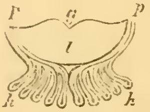

Fig. 14.

Fig. 15.

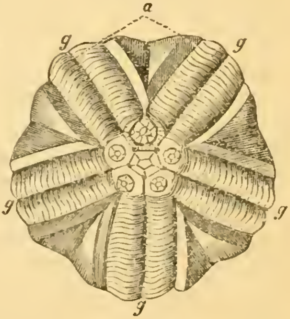

Fig. 12. Diagrams of one pair of the hydrospires of a Pentremite: *a*, the inner side; *b*, the outer, or side attached to the shell; *f*, the fissures. Fig. 13. Section across an ambulacrum of a specimen of *P. Godoni*, enlarged 3 diameters: *l*, lancet plate; *g*, ambulacral groove; *p p*, pores leading into the hydrospires; *h h*, the two hydrospires, in transverse section. Fig. 14. Ideal figure of a transverse section through an entire specimen, showing the ten hydrospires: *l*, one of the five lancet plates; *p p*, pores; *r r*, the two branches of one of the radial plates. Fig. 15. Summit of *P. conoideus*: *a*, anterior side; *g*, ambulacral grooves (copied from Dr. Shumard, but with the ovarian pores added).

not "ovarian orifices." The large anterior aperture would thus be the *oro-anal spiracle*. Applying this system of terminology to other groups, the so-called ovarian orifice of the Cystidea, the homologous aperture of *Nucleocrinus*, *Codaster*, *Granatocrinus*, and of the palæozoic Crinoidea generally (but not of the recent forms) should be styled the *oro-anal orifice*.

I think that the side of an Echinoderm in which the mouth is situated should be called "anterior," even although the anus and the mouth be confluent in one orifice. Most starfishes have but one aperture for mouth and vent, and yet it is called the mouth by naturalists generally. Why not call the underside of a starfish "the anal or posterior side," and the central aperture the "anus?"

Dr. B. F. Shumard has shown (Trans. Acad. Nat. Sci. St. Louis, vol. i. p. 243, pl. 9. fig. 4) that in perfect specimens of *P. conoideus*, Hall, the six summit-apertures are closed by several small plates. In a specimen of the same species, sent me by Mr. Lyon, in which those plates are partly preserved, I find that there is a small pore in each of the five angles of the central aperture. The five ambulacral grooves enter the interior through these pores. I have copied his figure, but modified it by adding the pores, fig. 15. He also found that the summit of *P. sulcatus*, Roemer, was covered with an integument of small plates arranged in the form of a pyramid. From these facts he infers that in all the Pentremites the summit-apertures will be found, in perfect specimens, to be closed in a similar manner.

Dr. C. A. White, at present State Geologist of Iowa, in a paper on the same subject (Bost. Journ. N. H. vol. viii. pp. 481–488), describes *P. Norwoodii*, Owen and Shumard, and *P. stelliformis*, id., as having a similar structure; but he goes further: he considers the central orifice "*not to be the mouth*;" and I believe that he is the first naturalist who ever published such an opinion. His idea of its function is thus expressed:—"It seems more probable that, as the ova were germinated within the body, they found their exit through the central aperture, and were conveyed along the small central grooves of the pseudambulacral fields before mentioned, beneath the plated integument, to the bases of the tentacula, where they were developed and discharged as in the true Crinoids." I perfectly agree with Dr. White in this view. The central aperture is not the mouth; in fact, it is not a natural orifice, but a breach in the summit caused by the destruction of a portion of the vault. The true natural orifices of this part are those that I have discovered in *P. conoideus*, as above mentioned. They are the homologues of the *ovarian* *pores* at the bases of the arms of *Caryocrinus*, and in part, as I shall show in another part of these notes, of the ambulacral orifices of the true Crinoids.

With regard to the structure of the calyx of *Pentremites*, it is generally supposed that there are only three series of plates —the basal, radial, and interradial. Mr. Lyon has advanced the opinion that there are three small plates below those now called the basals (Geol. Ky. vol. iii. p. 468, pl. 2. fig. 1 *c*). I have examined a number of specimens with reference to this point, and I think he is right. There are three small pentagonal basals, the two upper sides of each of which are excavated to receive the subradials, *i.e.* those at present designated "the basals." They are in general anchylosed to the subradials; but in one of Mr. Lyon's specimens that I have seen they are distinctly separate.

[To be continued.]

XXVII.—*Note on an undescribed Fossil Fish from the Newsham Coal-shale near Newcastle-upon-Tyne.* By Albany Hancock, F.L.S., *and* Thomas Atthey.

For several years past we have been much puzzled with a large ichthyic tooth that is not by any means uncommon at Newsham. We could not make out to what fish to assign it. Indeed there is but one, of sufficient size, found in the locality, of which the teeth are not known, that was at all likely; and the remains of this were supposed to belong to *Rhizodus*; and as the teeth in question are perfectly devoid of cutting-edges, they could not belong to it. We had doubts, however, as to these remains really being those of that obscure fossil, and thought that probably they would be found some day or other associated with our unknown tooth—that it belonged, in fact, to these supposed *Rhizodus*-bones. And such is apparently the case.

A jaw has just been obtained at Newsham with one of these large enigmatical teeth attached, and the surface-ornament of the bone is of the same character as that of the remains alluded to. This jaw, which is a left mandible, is quite perfect in front; but the proximal extremity is broken away. The part that remains is upwards of seven inches long, and an inch and five-eighths wide; the margins are nearly parallel; the alveolar border is pretty straight, but rises up a little in front, which is rounded. About an inch behind the anterior extremity, a large stout laniary tooth is placed on this elevated part; it is slightly recurved, but the apex is gone. What remains measures an inch in length; the base is broad, being quite five-eighths of an inch wide; and the upper, broken extremity is three-eighths of an inch across. When perfect, this tooth could not be less than an inch and five-eighths in length, as is proved by comparing it with a perfect tooth of the same size at the base. The base is deeply folded, the folds being rounded and covered with minute, sharp, raised striæ, which pass upwards and die gradually out as they approach the broken extremity.

Along the alveolar border there are nine small teeth, three-eighths of an inch long; they have much the character of the large laniary tooth, exhibiting the same minute characteristic striation, but do not seem to be folded at the base. The first of these is about a quarter of an inch behind the large tooth; the next two are about the same distance apart from each other and from the first tooth; the fourth, fifth, and sixth are divided from these and from each other by a space of five-eighths of an inch; the seventh is a little more than one-eighth of an inch from the sixth, and a quarter of an inch from the ninth, which is an inch and a quarter from the broken extremity of the mandible.

The whole surface of the dentary bone is covered with small rough tubercles, which have a tendency to run in lines, producing vermicular grooves. This peculiar character of bone-surface at once associates our mandibular fragment with the remains already referred to, and supposed to be those of *Rhizodus*, and for a description of which we must content ourselves, on the present occasion, with referring to our paper "On Reptiles and Fishes from the Shales of the Northumberland Coal-field" (Ann. Nat. Hist. ser. 4. vol. i. p. 346). But we may remark that among these remains are many well-marked fragments and several perfect crescentic gill-plates or opercula, the largest being six inches in length; but one recently acquired is seven inches long; and a broken specimen in our possession could not have measured much under eight inches when perfect. There are also described along with these remains two or three jugular plates six inches long; and these are associated with a number of the body-scales, three inches in diameter, usually supposed to be those of *Rhizodus*.

Here, then, we have the crescentic opercula usually attributed to *Rhizodus*, and jugular plates, with many other bones, all having the surface-ornament similar to that assigned to that fossil, and associated with the body-scales described as belonging to it—all occurring in a locality where the unmistakable tooth of the large *Rhizodus* has never yet been found. And in this locality another large tooth occurs, with peculiar characters, and has now been found attached to a jaw the surface-ornament of which perfectly accords with that of the above-mentioned remains. However it may be with *Rhizodus*, it would therefore seem impossible not to adopt the conclusion that all these specimens belong to one and the same fish; and the tooth proves that they can have nothing to do with *Rhizodus*. For this fish, then, so characterized, and which seems to us to be generically as well as specifically new, we propose the name *Archichthys sulcidens*.

We must add, before concluding this note, that the teeth of our new fish sometimes measure two and a half inches in length and are upwards of an inch wide at the base, and that upwards of a score of specimens of it have occurred at Newsham. It is therefore pretty certain that they never attain the dimensions of those of *Rhizodus*, from which they can always be distinguished by their rotundity, the total absence of cutting-edges, and the fine striation of the surface, though they are folded at the base in a manner similar to those of that great enigma.

We may also add that thirteen opercular plates have been found, some being quite perfect and in excellent condition. The scales, too, are not by any means rare in the same locality. The remains, then, of this fish being so abundant, the non-occurrence of the large *Rhizodus*-tooth is very significant.

XXVIII.—*On a new Species of* Sagitta *from the South Pacific* (S. tricuspidata). By Wm. S. Kent, F.Z.S., F.R.M.S., of the Geological Department, British Museum.

Some months since, Mr. T. J. Moore, the able Conservator of the Free Public Museum, Liverpool, received from the South Pacific, in company with *Leptocephali* and an infinite number of other oceanic forms (the produce of surface-dredging on the high seas), certain organisms of such a fish-like outward appearance, that they were consigned to the hands of a celebrated ichthyologist for identification. The peculiar armature of their cephalic region plainly indicated, however, that, if fish, they were very aberrant representatives of the class.

The privilege of examining them having been afforded me, the idea at once suggested itself that they belonged to that interesting group, most closely approximating to the Annelida, designated by Professor Huxley the Chætognatha, and of which *Sagitta* constitutes the single genus.

Subsequent investigation substantiated the correctness of the inference primarily arrived at, and at the same time demonstrated that this form, while presenting all the characters essential to *Sagitta*, possessed others which seemed to entitle it to be ranked as a species distinct from all those that had been previously described.

The most recent and exhaustive synopsis of this genus is given in the pages of the 'Quarterly Journal of Microscopical Science' for 1856, by Prof. Busk. In this synopsis Mr. Busk gives the characters of seven distinct species; with none of these, however, have I found it possible to associate the form to be here introduced.

This species, for which I shall here propose the name of *Sagitta tricuspidata* (for reasons to be hereafter explained), is of large dimensions, measuring very little short of an inch and a half in its entire length; in regard to size it approaches *S. lyra*, but it is found, on closer comparison, to be very distinct from that species. In *Sagitta lyra* the two pairs of lateral fins are described as being apparently continuous with each other, while at the same time the portions belonging to the anterior set are much larger than those belonging to the posterior ones, and extend far forward. In *S. tricuspidata*, on the other hand, the two pairs of fins are distinctly separate, and the anterior ones do not extend beyond the posterior half of the lateral margin of the animal's body, and are of smaller dimensions than the two hinder ones. In this respect it seems more closely to resemble *Sagitta bipunctata*; but in the armature of the cephalic region, which forms the most striking and important character of this species, it is found to differ essentially, not only from the two species already referred to, but from all *Sagittæ* that have been hitherto described.

In all these this armature is described as consisting of two elements:—in the first place, of an outer series of large curved corneous hooks or "falces," which are transversely movable, and bound the lateral margin of the head on either side; and, in the second place, of an interior set of smaller hooks or "denticles," disposed in two series, one behind the other, on either side of the median line, and immediately in front of the buccal orifice.

In *S. tricuspidata* the large lateral falces are greatly developed, as indicated in the accompanying woodcut; but the interior series or denticles are almost entirely aborted, or, at most, represented in a very rudimentary condition—the only structures in any way homologous to these being, first, three stylate setæ set on a slightly raised prominence situated on either side of the anterior portion of the head (see fig. 2, *a*), and, again, a single solitary seta occupying a position midway between these and the large lateral falces (fig. 2, *b*); and it is in reference to the first-mentioned of these structural peculiarities that the specific name of *tricuspidata* has been applied to it.

This peculiar armature of the head, just described, is the more easily appreciated when compared with that of *Sagitta bipunctata*, represented in fig. 3, and sharply separates it from that or any other recorded species.

Fig. 1.

Fig. 2.

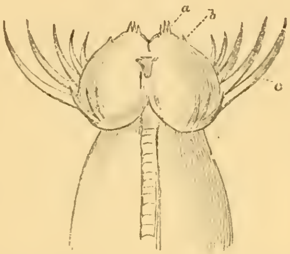

Fig. 3.

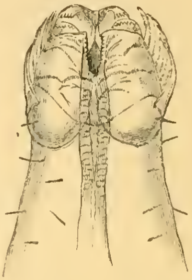

Fig. 1. *Sagitta tricuspidata*, nat. size: *a*, alimentary track; *o*, an ovary; *sp*, orifice of one of the spermatic cavities.
Fig. 2. Head of the same, viewed from beneath, considerably enlarged: *a* & *b*, the modified denticles; *c*, the lateral falces.
Fig. 3. The same region, under like conditions, of *Sagitta bipunctata*. (After Busk.)

In technical language, the characters of this new form may be briefly drawn up as follows:—

Sagitta tricuspidata, sp. nov.

Body long, somewhat stout. Caudal region one-fifth of the length of the entire body, exclusive of the head. Lateral fins distinctly separate from one another; the anterior pair smaller than the posterior. Caudal fin moderately large. Falces bounding the lateral margins of the head, eight in number on either side, those occupying a median position being much the largest. The anterior margin of the head bearing a slight prominence on either side of the median line, and in which are inserted three stylate setæ, a similar solitary seta also occupying a central position on each side between these and the lateral falces.

Entire length of the body 36 millims.; greatest breadth of the same 5 millims.

Habitat. The South Pacific.

The integument of this species, as preserved in spirit, was smooth and very transparent, and appeared to be quite devoid of the fine setæ scattered over its surface or arranged in fascicles which have been observed in *Sagitta bipunctata* and other allied species; it is possible, however, that these latter were present when the animal was alive, their extreme tenuity and their slender attachment to the surface of the integument rendering them exceedingly liable to become detached. One specimen, when submitted to dissection, exhibited most clearly the peculiar and characteristic nervous system described by Professor Huxley, and which induced that eminent comparative anatomist to refer this aberrant genus to the Annulose section of the Invertebrata, and to consider it most closely allied to the Annelida in that section. This nervous system consists essentially, in the first place, of a single ganglion lying in the abdominal region, from which proceeds both forwards and backwards a pair of lateral chords, the posterior ones terminating separately in fimbriated extremities, and the anterior ones uniting with each other above the œsophagus so as to form an hexagonal cerebral ganglion, which gives off two processes, said by Krohn to terminate in the muscles which effect the motion of the falces, and two others which, passing backwards for a short distance, dilate at their extremities and form the optic ganglia.

The ovaries in the specimens examined were very large and distinct, measuring in one instance one-third of the entire length of the animal's body, and demonstrated moreover that the animal had arrived at its adult condition.

Since Mr. Busk published his monograph of the genus, already referred to, he has also recorded, in the pages of the same journal (1858), the particulars of the development of this interesting genus, as elucidated by the researches of Gegenbaur, but which had previously been involved in much obscurity. That astute naturalist, by confining pregnant individuals of *S. bipunctata* and other species from the Mediterranean in glass receptacles, obtained ova which were found to develope immediately into the adult form without undergoing any metamorphosis. These ova or spawn were enclosed in a common gelatinous investiture, and in this respect likewise showed their affinity to the Annelida rather than to the Mollusca, of which latter class, in the earlier part of their history, the *Sagittæ* had previously been looked upon as aberrant representatives.

Subjected to a high power of the microscope, the edges of the falces of *S. tricuspidata* are found to be perfectly smooth and entire, and this in contradistinction to those of *S. serrato-dentata*, of which the inner edges are described as being serrated for about one-half of their length.

As regards the systematic position and significance of the species here introduced, it would seem, in the modification of its denticles, to indicate a slightly closer relationship to the ordinary forms of the Annelida than the other representatives of the genus, stylate setæ set in elevated prominences being of such general occurrence throughout the *Errantia* and *Tubicola*.

XXIX.—*On the Pairing of Zoospores, the Morphologically Fundamental form of Reproduction in the Vegetable Kingdom.* By N. Pringsheim*.

The author states that he has previously shown, from observations on some genera of the *Zoosporeæ*, that those reproductive cells which had been considered resting-spores are the female reproductive organs. The male organs in some genera have the form of small bodies more or less differing from the zoospores; in other genera they are so like the zoospores that they appear to be only smaller forms of the latter.

The views thence derived with regard to the multiplication and reproduction of these plants might be assumed to be applicable to all those *Zoosporeæ* in which two forms of zoospores are known, and in which the existence of resting-spores is known or suspected.

But in most genera of Algæ in which zoospores exist, resting-spores have not yet been discovered; and in those genera in which two forms of zoospores are known, it has been assumed that both kinds are of the same nature, and that they germinate without any sexual act. The author has shown that in some genera which have two kinds of zoospores and no resting-spores, the small zoospores, passing into a state of immobility, become themselves resting-spores, and that these resting-spores, produced by the so-called microgonidia, reproduce the mother plant.

These different views must admit of being reconciled, unless it be assumed that essential differences in the mode of increase and reproduction exist in such nearly allied plants. If it be not assumed that all the plants without resting-spores are asexual, it must follow either that their resting-spores remain to be discovered (which is improbable), or that in the *Zoosporeæ*, and in their already known organs, the sexual act takes place in a special manner not yet discriminated. The

* From the 'Monatsbericht' of the Royal Academy of Sciences of Berlin, Oct. 1869.

existence of two kinds of zoospores in the same plant seemed to afford a clue to the discovery of this unknown sexual act.

The discovery announced in this paper is that of a modification of the sexual act, forming a link between the known forms of reproduction, and showing that the different sexual products are a series of variations, passing into one another, of one and the same form. This modification is here called "pairing of zoospores;" and the essential difference between this and other processes of reproduction lies in the appearance of motile brood-spheres*, which are externally just like the zoospores.

The plant in which this modification occurs is *Pandorina Morum*, a plant the different states of which have given rise to a number of groundless and confusing genera, and which is often confounded with another nearly allied Volvocine, *Eudorina elegans*.

Until the appearance of the phenomena introductory to reproduction, the plants are distinguishable by the form and arrangement of their green cells. *Pandorina* has somewhat wedge-shaped cells. The base of the wedge is turned outwards; and the cells, which are in close connexion with one another, entirely fill the oval cavity which is enclosed by the general envelope of the plant. *Eudorina*, on the other hand, has spherical cells arranged in a single layer at the periphery of the envelope, and at regular, almost equal, distances from one another. The structure of the cell is identical in both plants, and similar to that in the other *Volvocineæ*.

The number of cells in *Pandorina* is typically sixteen, occasionally less, in *Eudorina* thirty-two, sometimes fewer.

Asexual reproduction takes place in *Pandorina*, as in other multicellular *Volvocineæ*, by the formation of a perfect young plant in each cell of the mother plant. By the gradual dissolution of the general envelope and of the special membrane of the mother cells, the young plants become free and escape.

In sexual reproduction, as in the asexual, the membrane of the old plant swells, and sixteen young plants are formed. The young plants, however, are (at least in part) not neuter, but sexual, and either male or female. Whether the mother plant is monœcious or diœcious is difficult to determine, because the male and female plants are externally alike, and can hardly be distinguished with certainty during copulation. There is no striking difference in structure between the sexual and asexual plants, although, amongst the former, plants with

* [It is difficult to translate the German word "Befruchtungskugel." It is used to express the spore or globular mass of protoplasm before it has been fertilized by the action of the spermatozoids.—Tr.]

less than sixteen cells, especially with eight cells, are oftener produced. Moreover the dissolution of the membrane of the mother cell proceeds more slowly than in the case of neuter plants, one result of which is that the young sexual plants vary much in the extent of their growth, and continue united in groups of different sizes for a long time after their formation, according as a greater or less number of them have happened to become free from the gelatinous mass in which they were imbedded.

As the individual groups are at first motionless, and the mother plant loses its cilia during the formation of the young ones, the entire group is at first entirely quiescent. But afterwards the young sexual plants, like the neuter ones, produce upon each of their cells two cilia, which commence their motion as soon as the enveloping mucus admits of it; and thus ultimately the entire group assumes a state of active rotation. During the rotation of the groups the same process of expansion and dissolution takes place in the membrane of the sexual plants as occurred in the mother plant; but the contents of the cells of the sexual plants do not undergo division, but combine to form a single zoospore, which becomes free by the rapid dissolution of the membranes.

In their general structure these zoospores differ in no way from other zoospores. At their colourless apex they exhibit, like other zoospores, a red body placed on one side of the apex, and two long vibrating cilia, by which they move in the manner common to zoospores.

The individual zoospores exhibit no marked differences, except that (like the sexual plants from which they spring) they vary in size within tolerably wide limits, but not in a manner to indicate the existence of two different sorts.

Amongst the groups of isolated zoospores of different sizes, some are at last seen to approach one another in pairs. They come into contact at their anterior hyaline apex, coalesce with one another, and assume a shape resembling a figure of 8*. The constriction which marks their original separation disappears by degrees; and the paired zoospores form at last a single large green globe, showing at the circumference no trace of their original separation. It may be seen, however, that the globe is larger than the individual neighbouring zoospores, that it has a strikingly enlarged colourless mouth-spot, with two red bodies on the right and left, and that it is furnished with four vibrating cilia originating in pairs near the

* [The German expression is "biscuit-artige Gestalt," but this, if translated literally, would convey no idea to an English reader.—Tr.]

two red spots. The four cilia, however, soon become motionless, and, together with the red spots, disappear.

This act of conjugation occupies some minutes, *i. e.* from the first contact of the zoospores to the formation of the green globe. The latter becomes the oospore, which, after growing slightly larger and assuming a red colour, germinates after a long period of rest, and brings forth a new *Pandorina.*

There is hardly any appreciable difference, except in size, and that to no reliable extent, between the male and female zoospores. Most frequently a small zoospore pairs with a larger one; but two of equal size (either of the larger or smaller forms) often unite. Probably both the females and the males vary much in size, the former more so than the latter.

With regard to the entire plants from which the zoospores are produced, there is little doubt that those of the largest size are females; but the sex of the smaller and middle-sized ones cannot be determined with any certainty.

The germination of the oospore is like that of other *Volvocineæ*, especially resembling in its early stage the germination of the resting-spores produced by the microgonidia of *Hydrodictyon utriculatum.* The oospore bursts and produces a single large zoospore (in rare cases two, or even three), which divides into sixteen cells and becomes a young *Pandorina.*

[The author then remarks that Cohn (in *Volvox*) and Carter (in *Volvox* and *Eudorina*) describe the spermatozoids as differing materially from the zoospores, and that they speak of the brood-spheres as globular resting-cells. Whilst suggesting some possible modes of reconciling the observations of Cohn and Carter with his own on *Pandorina*, the author admits that further investigation of *Volvox* and *Eudorina* is necessary.]

A comparison of the relations between the sexual act in *Pandorina Morum* and that in other plants seems to afford a clear insight into the gradual changes in the sexual products and the sexual act in plants.

Hitherto the conjugation of the *Zygosporeæ* has appeared to have no affinity with the sexual act in other Algæ; and these plants seemed, therefore, to form a sharply defined separate group.

Considering that in most plants the sexual organs differ much in form and size, the doubts as to the copulation of the *Zoosporeæ* seemed reasonable. The pairing of the zoospores which takes place in *Pandorina* with hardly even an incipient differentiation of the sexual organs, seems to be a fresh instance of the act of copulation occurring in plants with motile sexual organs, and it forms, therefore, a bridge between the *Zygosporeæ* and the *Zoosporeæ*; and perhaps a more complete knowledge of the mode of conversion of the microgonidia into resting-spores in the *Chætophoreæ*, and especially in *Draparnaldia*, will disclose the peculiar bond of union between these two divisions of the Algæ.

Whilst this pairing is connected, on the one hand, with the copulation in the *Zygosporeæ*, it is still more closely allied, on the other hand, with the known sexual process in the *Zoosporeæ*.

Comparing the sexual act in *Pandorina* and *Œdogonium*, we find that the anterior, colourless, protoplasmic mass of the brood-sphere of *Œdogonium*, in front of which, as in *Pandorina*, the coalescence with the spermatozoid takes place, is identical with the so-called "mouth" (*Mund-Stelle*) of one of the two pairing zoospores of *Pandorina*, and with the so-called "mouth" of the directly germinating zoospores of *Œdogonium*. It may be taken to be undeniable that the resting brood-spheres of *Œdogonium*, as well as those of *Vaucheria* and *Coleochæte*, to which those of other Algæ which have a less defined or hardly perceptible germ-spot are closely allied, are only unciliated resting-forms of zoospores.

But the analogy of the structure of the brood-sphere and the zoospore may be extended far beyond the Algæ.

It would seem to be a result of the foregoing that that which in the embryonic vesicle of the Phænogams has been called by Schacht the filamentary process (*Faden-Apparat* *) is an analogue of the colourless "locus of impregnation" (*Befruchtungstelle*) in the brood-spheres of Algæ, and of the mouth or germ-spot of the zoospores. The canal-cell observed in the central cell of the archegonium of *Salvinia*, and which seems to occur also universally in mosses and ferns, is a corresponding organ. The word "germ-spot" (*Keimfleck*) would be a convenient word to express the locus of impregnation of female plants in general, which term would include the "mouth" of the zoospores, the colourless protoplasmic

* [" *Faden-Apparat* " is the term used by Schacht to describe the anterior portion of the germinal vesicle in *Crocus Watsonia* and some other plants. He imagines that it exists in all plants in which the pollen-tube does not penetrate the embryo-sac, and he describes it as consisting of delicate cellulose threads radiating downwards. Schacht's observations have been questioned by Hofmeister, but were partly confirmed by the late Professor Henfrey. The reader may refer to Schacht's papers on the impregnation of *Gladiolus segetum* (Bot. Zeitung, Jan. 15, 1858), on the impregnation of *Crocus vernus* (Regensb. Flora, Sept. 21, 1858), and on the impregnation of *Santalum album* (Pringsheim's 'Jahrbücher für wiss. Bot. vol. iv. p. 1), also to Hofmeister's remarks in the 'Bonplandia' for 1856, p. 287, and in Pringsheim's 'Jahrbücher für wiss. Bot.' vol. i. p. 162, and to Professor Henfrey's paper on "the Development of the Ovule of *Santalum album*," in Trans. Linn. Soc. vol. xxii.—Tr.]

mass at the fore end of the brood-spheres, the canal-cell of the higher Cryptogams, and the filamentary process (*Faden-Apparat*) in the embryonic vesicle of Phænogams.

Those cases amongst the Algæ where, as in *Œdogonium* and *Pandorina*, the entire mass of the brood-sphere, including the whole of the germ-spot, is employed in the formation of the embryo, are introductory to the procreative act in *Vaucheria*, where a portion of the germ-spot is pushed away and cast off before impregnation; and through *Vaucheria* and the analogous formative process in *Coleochæte* the passage is direct to the canal-cell and the filamentary process. Thus the zoospore appears as the ground-form of the embryonal rudiments in the vegetable kingdom; and in the formation of these there is a striking analogy to the phenomena which, in the formation of the embryo in animals, are distinguished as total and partial segmentation.

It may also be worth while to call attention to the fact that, in comparing embryonic vesicles and zoospores, the position of the brood-sphere before impregnation throws light upon the direction of the root of the embryo in those plants in which an embryo is the result of the procreative act, inasmuch as the germ-spot, which from *Œdogonium* up to the Phænogams is without exception turned towards the sexual aperture, corresponds, as the zoospores show, to the *foot* of the germ.

But it being the fact (as is shown by the spermatozoids of *Œdogonium* and *Pandorina*) that the differences in form which have been hitherto attempted to be established between spermatozoids and zoospores have only a relative value as modifications of the same primary form, it will follow that the form of the zoospore, in which even the oldest observers noticed a connecting link between the vegetable and animal kingdoms, may be recognized as the ground-form of all reproductive bodies in plants, and thus an embryological unity may be distinguished in the vegetable kingdom, unless the mode of copulation of the *Florideæ* and the *Fungi* should turn out to be very divergent, as to which further observations must decide.

It is probable that a number of ill-understood phenomena and of unintelligible contradictions of reliable botanists as to the form and colour of microgonidia, as to the number of their cilia, as to their behaviour after the cessation of their mobility, and, lastly, probably, as to double spores, may be fully explained by the supposition of the process of pairing.

It should now be the object of those observers who are occupied in investigating the development of Algæ to look for the phenomenon of "pairing," or for motile brood-spheres, in all those *Zoosporeæ* in which hitherto zoospores only have been found.

The following is a short summary of the results of this paper:—

1. In the division of the *Zoosporeæ* there are to be found motile brood-spheres which appear in the form of zoospores.

2. The resting brood-spheres are more or less abnormal forms of the zoospore, devoid of cilia.

3. The colourless anterior end of the brood-spheres of Algæ, the "canal-cell" of the higher Cryptogams, and the "filamentary process" of Phænogams are structures which are morphologically identical with the so-called mouth, germ-spot, or, what is the same thing, the *foot* of the zoospore.

4. By analogy to the phenomena of total and partial segmentation in animal ova, it happens in plants that sometimes the entire mass of the brood-sphere is appropriated to the formation of the embryo, sometimes only a portion of it; in the latter case there occurs an entire (?) or partial casting-off of the colourless foot of the brood-sphere, which casting-off occurs sometimes before (as in *Vaucheria*, *Coleochæte*, and *Salvinia*), sometimes after (?) impregnation (as in Phænogams).

5. The remarkable phenomenon that the zoospore is the morphologically fundamental state of the reproductive organs, is an argument for the embryological unity of the vegetable kingdom, and shows that there is a morphological as well as a histological point of contact between it and the animal kingdom.

XXX.—*A last word in Reply to* Dr. Chapman *and* Mr. Frederick Smith *on the Relations of the Wasp and* Rhipiphorus. By Andrew Murray.

The subject has now been so fully ventilated that further discussion seems unnecessary. We have reached that stage when little more can be said on either side until further observation shall have given us fresh materials to argue from. The discussion which has taken place, however, has been of good service in clearing away irrelevant matter, and showing us where the pinch really lies. I trust that Dr. Chapman may have every success in his researches during the ensuing summer; and should he succeed in proving me to be in the wrong, I promise to make him my fullest and handsomest acknowledgments.

To Mr. Smith I have still an answer to make.

In the postscript to my last paper I said:—"I had also the pleasure of showing to Mr. Smith my specimens of pupæ [of *Rhipiphori*] with the cast skin still sticking to their tail, and I think he will no longer" &c.

In his reply Mr. Smith writes, "The last paragraph of the postscript is entirely suppositional. Mr. Murray has not shown me any of his specimens."

Mr. Smith's memory is as much at fault as his courtesy. According to my recollection, when I went to see his specimens, I took my own with me to him at the British Museum, and then and there showed them to him. They were in small flat glass phials, preserved in Canada balsam; and I have a vivid impression on my mind of Mr. Smith examining them against the light with his pocket-lens, when I pointed out the cast skins adhering to the tails; and that he then made some remark which led me to conclude that he accepted the inference I drew from them; but, as it was not made explicitly, I stated this merely as my belief.

I scarcely think that I could have dreamed all this; and as a visit to the British Museum with specimens in hand is for me a sufficiently rare event to make some impression on my mind, whilst with Mr. Smith it must be the exception to have a day pass without numbers of visitors bringing specimens for examination, I do not think that I am any way unreasonable in claiming for my positive recollection (positive in its double sense) a preference over his negative assertion—that is, always supposing it to be put as a matter of memory, which, notwithstanding his peculiar mode of expressing himself, I do not doubt Mr. Smith to mean it to be. If, however, it is as a matter of veracity that Mr. Smith really puts it, I can only make him my bow once and for all, and leave him in the enjoyment of his own opinion, consoling myself with the assured conviction that it will be shared by no one but himself.

XXXI.—*On* Ornithopsis, *a Gigantic Animal of the Pterodactyle kind from the Wealden.* By Harry G. Seeley, F.G.S., Assistant to Prof. Sedgwick in the Woodwardian Museum of the University of Cambridge*.

The two vertebræ to which I would here call attention are in the British Museum; other remains allied to them were shown to me with much courtesy by the Rev. Mr. Fox, of Brixton. From these materials I am led to infer the existence of a new

* Communicated by the Author, having been read before the Cambridge Philosophical Society, Nov. 22, 1869.

order of animals. One of the British-Museum fossils is from Tilgate; the other, probably from the Isle of Wight, is labelled South-east of England. They are of size and structure and texture such that both might well have belonged to the same kind of organism; and as no other remains are known to which either bone approximates, they are here considered to indicate the same animal. One vertebra is from the lower part of the neck, and the other from the lower part of the back. When perfect, the neck-vertebra can scarcely have measured less, from the back to the front of the centrum, than ten inches. The neck would appear to have been carried erect, after the manner of birds. If seven cervical vertebræ were to be presumed (and there can scarcely have been fewer), it would give a neck from four to five feet long, and an animal of a minimum height of from ten to twelve feet, while it is not impossible that it may have been twice or three times as high. Both vertebræ agree in being constructed after the lightest and airiest plan, such as is only seen in Pterodactyles and birds; and they agree in possessing pneumatic foramina, which are an avian and ornithosaurian peculiarity. The foramina are of enormous size, and approximate to those of Pterodactyles rather than to those of birds. Seeing that in living animals these foramina exist for the prolongation of the peculiarly avian respiratory system into the bones, and that no other function is known for them, we are compelled to infer for this animal bird-like heart and lungs and brain. Both in Pterodactyles and birds one type of brain coexists with these foramina; therefore there is no reason to suspect a different organization for these specimens.

Our animal is therefore clearly ornithic. But it does not conform closely in the shape of vertebræ to either Pterodactyles or birds. And from the bones preserved, and many other indications of allied animals which I have seen from the Wealden and Potton Sands, I anticipate that it will form the type of a new order of animals which will bridge over something of the interval between birds and Pterodactyles, and probably manifest some affinity with the Dinosaurs.

In view of these considerations it is impossible not to recall with interest the gigantic ornithic footprints described by Mr. Beccles and Mr. Tylor from the Wealden. They might not improbably have been the tracks of this animal.

The Mantellian specimen in the British Museum, numbered 28632, is apparently a late cervical vertebra, with the centrum about nine inches from front to back, six inches from side to side, and about seven inches from the base of the neural canal to the base of the vertebra. It is much worn, the neural arch being too much abraded to give evidence of zygapophyses or neural spine, or the extent of the transverse processes.

The posterior articulation is vertically ovate and well cupped; seen from the side, its outline is concave, so as to admit (apparently) of lateral motion upon the adjacent centrum. In front the body of the vertebra is rather larger than it is behind, and convex; but it has been worn so that the whole of the external layer of bone over the anterior articulation has been removed: it was of paper thinness, as in the Pterodactyles. Wherever this external film is wanting is seen either an absolute cavity or enormous honeycomb-like cells of irregular polygonal form, for the most part long in the direction of the depth of the centrum, and divided by exceedingly thin and compact films of bone, which extend towards the articular ends of the vertebra.

In the middle of the upper part of the side of the centrum, below the level of the neural canal, is an enormous subtriangular hole lined with a continuation of the external bone for some distance inward. It is more than a third of the length of the centrum, longer than high; its upper angle is above the level of the base of the neural canal; and it narrows towards the concave end of the centrum. This large hole, between three and four inches long, is situate precisely as are the pneumatic foramina of Pterodactyles, and in this specimen is regarded as a pneumatic foramen which supplied the bone with air from the lungs after the plan of the class of birds.

In front of it the combined centrum and neural arch widen rapidly, as though for the attachment of a rib, though possibly the thickening may be only such as characterizes the neck-vertebræ of birds.

The external surface is dense and smooth, and gently concave from front to back, where the margin of the posterior cup is prominent. From above downward the sides are convex, and approximate in a natural compression so as to form an inferior mesial antero-posterior ridge.

The neural canal posteriorly is subovate, higher than wide, and about three inches high.

The lateral compression of the centrum is altogether avian; and in the anterior enlargement it resembles birds rather than Pterodactyles, though herein recalling certain Dinosaurs. The opisthocœlous centrum may be matched among mammals, Dinosaurs, and a few natatorial birds.

In the 'Geology of the South-east of England,' Dr. Mantell figured, at pl. 2. fig. 5, a bone which he describes as the tympanic bone of *Iguanodon*, at pp. 305, 306 of that work.

He compares the fossil to the tympanic bone of *Mosasaurus*, with which it certainly has no near resemblance. In the Palæontographical Society's volume for 1854 (Dinosauria, part 2), Professor Owen figured a similar bone, which he agreed with Dr. Mantell in regarding as the tympanic bone of *Iguanodon* (p. 18), but suggests that it may possibly belong to *Cetiosaurus* or *Streptospondylus*. This specimen I interpret as the lower dorsal or lumbar vertebra of *Ornithopsis*.

Dr. Mantell's description is as follows:—

"In these bones the body bears some resemblance to a vertebra, but the large cells or hollows which pervade it throughout readily distinguish it; it forms a thick pillar or column, which is contracted in the middle, and terminates at both extremities in an elliptical and nearly flat surface: two lateral processes or alæ pass off obliquely, and are small in proportion to the size of the column. . . . From the great size of the body in the fossil and the extreme thinness of its walls, the tympanic cellulæ must have been of considerable magnitude."

In this description there is not one character which can reasonably be presumed to characterize the quadrate bone of *Iguanodon*, or which is inconsistent with the identification of the fossil as a lumbar vertebra; for the cellular character, which weighed with Dr. Mantell against making such a determination, is seen, from the previous description of a cervical vertebra, to be evidence in its favour. The following characters are shown in Professor Owen's or, rather, Mr. Dinkel's figure. The centrum, from seven to eight inches long, shows large internal air-cells and a dense outer film, like the specimen 28632. Posteriorly the articular surface is about four inches deep, subcircular, and slightly hollowed. Anteriorly the centrum seems to be larger; but the articular surface is not preserved. The centrum is subcylindrical, expanded towards both ends, so as externally to be concave from front to back all round.

The pneumatic foramen is placed towards the anterior end of the vertebra, between the centrum and the neural arch. It is from two to three inches in length, compressed behind, about an inch high, and rounded in front.

The lunate mass, in Prof. Owen's figure, above the pneumatic foramen, is the transverse process. It is an exceedingly thin and dense film, only comparable to the transverse process in similar vertebræ of birds.

The affinities of this specimen are in accordance with the avian type. If supposed to belong to an animal of like species with the cervical vertebra, it would resemble Pterodactyles in the smaller size of the back relatively to the neck; in the elongation of the centrum it resembles the lower dorsal vertebræ of birds.

I have made this note, not as a sufficient description of the specimens to which it relates, but in the hope that other parts of this and allied animals may be made available for scientific description by those collectors who possess them, and that they will so make known a group of animals as marvellous in size and organization as any which have enriched the records of palæontology. With the fossil I would associate the name of my friend Dr. Hulke, chronicling the species as *Ornithopsis Hulkei.*

XXXII.—*On* Zoocapsa dolichorhamphia, *a Sessile Cirripede from the Lias of Lyme Regis.* By Harry G. Seeley, F.G.S., Assistant to Professor Sedgwick in the Woodwardian Museum of the University of Cambridge.

Among some Lias fossils obtained at Lyme Regis by Mr. Henry Keeping, for the Woodwardian Museum, was one which exposed a portion of the tergum of a sessile Cirripede. It rested in a hard matrix of calcareous clay, immediately upon a layer of Pentacrinite-limestone; and it was not till after some days of dissecting that I had the pleasure of laying bare the entire tergum and entire scutum of the oldest known representative of the group. Every way it is a remarkable fossil: the scutum closely resembles that of the pedunculate Cirripede *Scalpellum*; the tergum, by its long beak, recalls certain *Balani*; while the emargination of its basal border points strongly to another beaked type, *Elminius*. Yet as it fortunately happens that the internal aspect of these opercular valves is exposed, it is manifest that neither valve displays the muscular scars which distinguish the Balanidæ; and herein they resemble the Verrucidæ. But since the shape and articulation of the valves offer no resemblance to *Verruca*, it is open to speculation whether an inner porcellanous layer of shell has disappeared, and so obliterated the muscular impressions—a supposition which is, perhaps, supported by the scutum being rough and cancellate internally, seemingly from reproducing the outside ornament. From the tergum and scutum being in juxtaposition, and these valves being only two in number, there is some support for a Verrucian hypothesis; yet from the articulation of the valves conforming to the straight-hinge type of *Balanus*, it is probable that, unless we have here a new family type (as I incline to believe), its place is among the Balanidæ.

The *scutum* is four-sided, as in *Scalpellum*, but wider from the tergal margin to the occludent margin along the straight base than it is high from the basal margin to the apex. The basal margin is slightly inflected. The occludent margin, as in *Coronula*, is moderately concave from base to apex, the extremity of which is not exposed: in the living genera it is straight or convex. This margin is destitute of the inflexion so characteristic of recent sessile Cirripedes, and therein is more like *Scalpellum*. The two remaining margins are straight, make a large angle with each other; and both join the tergum. The upper margin, seemingly the longer of the two, fits against the beak of the tergum; the tergal margin articulates with the tergum in the usual way. Externally the scutum was slightly convex and cancellate. The four-sided form is clearly a consequence of the prolongation of the beak of the tergum, and therefore no evidence of affinity, since the margin, which here is properly tergal, in *Scalpellum* would be lateral and be presented towards the upper latus. The species of *Balanus* with a beaked tergum have the scutum only three-sided, because the beak makes a slightly curved continuation of the tergal margin, and not an angular bend in it.

The *tergum* is an irregular, subtriangular, trilobed plate, formed of three unequal triangular parts, whose apices terminate with a long subcylindrical apex of uniform width, which is bent slightly inward so as to touch the scutum, when that plate meets it at an angle, as is common among the Balanidæ. On the basal margin is a deep emargination in its middle third, in the place where the spur is developed in *Balanus*; so that in this respect it rather approximates to a species of *Elminius*. This notch is at the termination of a wide depressed groove, triangular in outline, forming the middle third of the plate; it widens towards the basal margin, as is characteristic of the tergum in most of the Balanidæ. The third of the base towards the carinal margin, however, is much prolonged; it widens, and is rounded at its termination. The carinal margin is straight, except just below the origin of the apex, where it widens so as to present a prominent angle. The scutal margin is slightly inflected, much narrower than in living *Balani*, with the articulation formed by a very narrow articular groove, margined on the outside by an equally narrow articular furrow, which are adjacent to and extend the whole length of the scutal margin up to the apex.

Projecting from under the tergum is seen the greater part of another Cirripede plate. It is evidently not the other scutum, being smaller, nor the other tergum, nor one of the compartments; yet, from its association with the valves described, it is difficult not to regard it as part of the same individual, in which case it can only be the upper latus, and have been applied to the carinal margin of the tergum below the projecting angle already referred to. Its exposed exterior surface is flat, and shows broad, slightly elevated, wavy ribs, crossed by faint vertical lines of growth. The two sides seen are straight and meet at an angle of 45°.

On the other side of the tergum, and partly covered by it, is an unsymmetrical trilobed shelly mass, which I suspect to be one of the compartments. If so, the subparallel curved grooves upon it remind one rather of *Verruca* than of *Balanus.* But the specimen seems small for valves so large as those described.

Altogether the plates preserved would incline one to suspect that there were no more. By no ordinary arrangement could the valves close the aperture, if there were six. I therefore incline to regard the specimen as the type of a new family intermediate between Balanidæ and Verrucidæ, with peculiar affinities towards the Lepadidæ.

BIBLIOGRAPHICAL NOTICE.

Catalogus methodicus et synonymicus Hemipterorum Heteropterorum Italiæ indigenorum, accedit descriptio aliquot specierum vel minus vel nondum cognitarum. Auctore Antonio Garbiglietti, M.D. Florentiæ, 1869. Pp. 58.

This Catalogue is the result of the study of many years, in which the author, a distinguished Professor in the Medical Faculty of the University of Turin, has devoted his special attention to the collection of the Heteropterous Hemiptera inhabiting Italy. The work embraces 279 genera and 713 species, of which 162 are new to the Italian fauna. Interspersed in the text there are descriptions of 40 new or little-known species. The author has added the synonyms of the insects. He has embraced the Hemiptera of the Italian islands as well as those of the peninsula itself—those of Corsica, although belonging to the French Empire, and also of Venetian Dalmatia, although attached to the Austrian empire; for in matters appertaining to entomology it may be considered to be intimately connected with Italy. This Catalogue will be found to be valuable to entomologists.

PROCEEDINGS OF LEARNED SOCIETIES.

ROYAL SOCIETY.

March 24, 1870.—Lieut.-General Sir Edward Sabine, K.C.B., President, in the Chair.

On the *Madreporaria* dredged up in the Expedition of H.M.S. 'Porcupine.' By P. Martin Duncan, M.B. Lond., F.R.S., Sec. Geol. Soc., Professor of Geology in King's College, London.

Professor Wyville Thomson, Dr. Carpenter, and Mr. Gwyn Jeffreys have placed the collection of stony corals dredged up by them in the 'Porcupine' Expedition in my hands for determination. They have kindly afforded me all the information I required concerning the localities, depths, and temperatures in which the specimens were found.

My report has been rendered rather more elaborate than I had intended, in consequence of the great consideration of Professor A. Agassiz and Count de Pourtales in forwarding me their reports * and specimens relating to the deep-sea dredging off Florida and the Havana.

They have enabled me to offer a comparison between the British and American species, which I had not hoped to do before the publication of this communication.

Contents.

1. Twelve species of Madreporaria were dredged up, and the majority came from midway between Cape Wrath and the Faroe Islands. Others were also found off the west coast of Ireland. Many varieties of the species were also obtained, and some forms which hitherto have been considered specifically distinct from others, but which now cease to be so†. [See Table, p. 287.]

List of species known only on the area dredged, or in the neighbouring seas.

1. Amphihelia atlantica, *nobis*.
2. —— ornata, *nobis*.
3. Allopora oculina, *Ehrenberg*.

List of species common to the area and to the Florida and Havana deep-sea faunas only.

1. Balanophyllia socialis, *Pourtales*, sp.
2. Amphihelia profunda, *Pourtales*, sp.
3. Pliobothrus symmetricus, *Pourtales*, sp.

* Contributions to the Fauna of the Gulf-stream at great depths, by L. F. de Pourtales, 1st & 2nd series, 1868. Bull. Mus. Comp. Zool. Harvard College, Cambridge, Mass., Nos. 6 & 7.

† One specimen came from the 'Lightning' Expedition. It must be remembered that all the deep-sea corals known to British naturalists were not dredged up. The *Stylaster rosea*, for instance, was not amongst the collection.

List of Madreporaria.

Name.	No.	Latitude.	Longitude.	Depth.	Temperature.	Remarks.
		° ′	° ′	fathoms.	°	
1. Caryophyllia borealis, *Fleming*	2	51 57 N.	10 23 W.	30–40	52·00	Specimens very numerous.
Syn. C. clavus	...	......	......	......	......	The species is found in the coralliferous British seas and
C. Smithii	88	59 26 N.	8 23 W.	705	42·65	Mediterranean. Fossils in Miocene and Pliocene of Sicily.
C. cyathus and many varieties						At great depths in Mediterranean (recent).
2. Ceratocyathus ornatus, *Seguenza*	88	......	......	705	42·65	One specimen. Not known elsewhere; the genus is, with this exception, extinct. The species is fossil in the Sicilian Miocene.
3. Flabellum laciniatum, *Ed. & H.*	3	51 51 N.	11 50 W.	370	......	Specimens numerous.
Syn. Ulocyathus arcticus, *Sars* ...	25	56 41 N.	13 39 W.	164	46·5	This is a well-known Norwegian recent form.
4. Lophohelia prolifera, *Pallas*, sp.	5	52 4 N.	12 8 W.	364	48·8	Specimens numerous.
Syn. All the species hitherto published, viz.:—						The variability of this species at different depths is so great that all the known species must in consequence be con-
L. anthophyllites, *Ed. & H.* ..	13	[illegible]	13 55 W.	208	49·6	sidered varieties of one form. Recent in Norwegian seas,
L. subcostata, *Ed. & H.*	14	[illegible]	13 15 W.	173	49·6	Mediterranean, and off the Shetlands. Fossil in Miocene
L. affinis, *Pourtales*	15	[illegible]	12 7 W.	422	47·0	and Pliocene deposits of Sicily. A variety is found off the
L. Defrancei, *Defrance*	25	[illegible]	13 39 W.	164	46·5	American coast. A considerable number of specimens was
L. gracilis, *Seguenza* .... and several varieties.	54	59 56 N.	6 27 W.	363	31·5	found in the "cold area" at depths from 500–600 fathoms.
5. Amphihelia profunda, *Pourtales*, sp.	54	59 56 N.	6 27 W.	363	31·5	Many specimens.
6. —— oculata, *Linnæus*, sp.	54	......	......	......	......	The necessity for absorbing *Diplohelia* is stated in the following pages.
7. —— miocenica, *Seguenza*	54	......	......	......	......	The species of *Amphihelia* range from the Miocene to the
8. —— atlantica, *nobis*	54					present day; but only *A. oculata* has hitherto been found
9. —— ornata, *nobis*	54					in recent fauna.
10. Allopora oculina, *Ehrenberg*	54	......	......	......	......	A few specimens.
		59 40 N.	7 10 W.	530	47·0	Dredged in 'Lightning' Expedition. A recent form.
11. Balanophyllia (Thecopsammia) socialis, *Pourtales*, sp.	54	59 56 N.	6 27 W.	363	31·5	These are West-Indian forms, and are included in *Thecopsammia*, a subgenus, by Pourtales.
var. costata						
britannica						
Jeffreysia	65	61 10 N.	2 21 W.	345	29·9	
12. Pliobothrus symmetricus, *Pourtales*	...	......	......	500–600	Cold area.	It is a West-Indian form.

Total species, 12; species absorbed, 9. Good varieties numerous. Greatest depth from which species were dredged, 705 fathoms.
Lowest temperature of sea at bottom whence corals were dredged, 29°·9.

These forms are not known in the West-Indian Cainozoic fauna, and they have not been discovered in any European deposits.

Lophohelia prolifera (var. *affinis*) is common to the British and Florida deep-sea faunas; it is found fossil in the Sicilian Tertiaries, being moreover a member of the recent fauna of the Mediterranean.

List of species common to the area and to the Mediterranean sea.

1. Caryophyllia borealis, *Fleming*.
2. Amphihelia oculata, *Linnæus*, sp.
3. Lophohelia prolifera, *Pallas*, sp.

List of species found on the area dredged, and as fossils elsewhere.

1. Caryophyllia borealis, *Fleming*. Sicilian: Miocene and Pliocene.
2. Ceratocyathus ornatus, *Seguenza*. Sicilian: Miocene and Pliocene.
3. Flabellum laciniatum, *Ed. & H.* Sicilian: Calabrian, Miocene and Pliocene.
4. Lophohelia prolifera, *Pallas*, sp. Sicilian: Miocene and Pliocene.
5. Amphihelia miocenica, *Seguenza*. Sicilian: Miocene and Pliocene.

The deep-sea coral-fauna of the area dredged in the 'Porcupine' and 'Lightning' Expeditions is therefore composed of:—

5 species which have lasted since the early Cainozoic period.
1 Mediterranean species not known in Cainozoic deposits.
3 species of the deep-sea fauna of Florida and Havana.
3 indigenous species.
—
12

Two of the fossil species are represented in the recent fauna of the Mediterranean.

If the species which I have absorbed into others (in consequence of the light thrown upon the amount of variation in the deep-sea corals) were counted, the fossil forms would be in all 8.

The greatest depth from which *Madreporaria* were dredged was 705 fathoms, and the lowest temperature of the water in which they lived was 29°·9.

II. *Caryophyllia borealis*, Fleming.—Having collected a very considerable series of the *Caryophylliæ* from the seas around Great Britain, and having been supplied with several specimens of the Mediterranean species, I had some time ago compared the whole with the fossil forms from the Sicilian tertiary deposits and with each other. The numerous specimens of *Caryophylliæ* dredged up in Dingle Bay were especially interesting after I had arrived at satisfactory conclusions respecting the affinities of the above-mentioned British and Southern-European forms. The Dingle-Bay collection presented all the varieties of shapes (some of which had been deemed of specific value) which I had observed in the separate assemblages of specimens from the Mediterranean, the Sicilian tertiaries, and the British and Scottish seas.

A perfect series of specimens from all these localities can be so arranged as to show a gradual structural transition from form to form; so that the most diversely shaped *Caryophylliæ* can be linked together by intermediate shapes. The *Caryophyllia clavus* and *Caryophyllia cyathus* can be united by intermediate forms, and all of these to *Caryophyllia Smithii* and *Caryophyllia borealis*.

It is impossible to determine which is the oldest form; but they all appear to be reproduced by variation on some part of the area tenanted by the section of the genus. The variability of the *Caryophylliæ* of the Sicilian tertiary deposits is very marked; and it is equally so in the groups which live on disconnected spots in our waters. The Dingle-Bay series presents the greatest amount of variability, and indeed is most instructive; for by applying the range of it to the classification of such genera as *Trochocyathus* and *Montlivaltia* a great absorption of species must ensue.

The Dingle-Bay *Caryophylliæ* are evidently the descendants of those which lived in the Western and Southern-European seas before those great terrestrial elevations took place which were connected with the corresponding subsidence of the circumpolar land and the subsequent emigration of Arctic mollusca. They are not closely allied to the recent West-Indian species; but they occupy a position in the Coral-fauna representative of them. The same remark holds good with reference to the affinities of the recent and tho cretaceous *Caryophylliæ*. They are not closely allied, and they belong to different sections of the genus; but they hold the same positions in the economy of the old and new distribution of animal life, and the recent forms are representative of the older. The examination of the Dingle-Bay *Caryophylliæ* tends to prove that a species is really the sum of the variations of a series of forms.

A specimen was dredged up in 705 fathoms, temp. 42°·65 F., and it exactly resembles forms which are frequently found in 90 fathoms, and at a temperature slightly below that of the surface. M. Alphonse Milne-Edwards obtained some *Caryophylliæ* from the cable between Corsica and Algiers in 1110–1550 fathoms. The bathymetrical range of these forms is therefore very great. I have placed the species *borealis* in the first place, and regard the old species *C. clavus*, *C. Smithii*, and *C. cyathus* as varieties of it.

Ceratocyathus ornatus, Seguenza.—A beautiful specimen of this rare form was dredged up from a depth of 705 fathoms with some *Caryophylliæ* and a small *Isis*. The species is hitherto unknown except in the Sicilian miocene*.

Flabellum laciniatum, Ed. & H.—This is the *Ulocyathus arcticus* of the late Prof. Sars. Many specimens were dredged up; but most

* Seguenza, "Disquisiz. Paleont. int. ai Corall. Foss.," Mem. della Reale Accad. dell. Sci. Torino, serie ii. tomo xxi. 1864.

of them were broken, in consequence of the extreme fragility and delicacy of the theca. There are no pali; therefore Sars's terminology is not in accordance with the received system. The form was familiar to me from Seguenza's drawing of a dilapidated *Flabellum* (which is always found broken*); and it is now evident that *Ulocyathus* must give place to *Flabellum*. The species links *Flabellum* to *Desmophyllum*: it is not known in the recent Mediterranean fauna.

Lophohelia prolifera, Pallas, sp., is apparently a common coral in the north-western British seas.

			Temperature.
It was dredged up in No. 5	at a depth of 364	fathoms ..	48°·8
13	,, 208	,, ..	49·6
14	,, 173	,, ..	49·6
15	,, 422	,, ..	47·0
25	,, 164	,, ..	46·5
54	,, 363	,, ..	31·5

and also at a depth of from 350 to 600 fathoms in the cold area to the north-west.

All the specimens show great density of the calcareous skeleton; and active nutrition may be inferred to have gone on, on account of the repeated gemmation, the large size of the calices, and the numerical development of the septa. Great variability occurs in the corallites forming a stem; and the shape of the calices is very diverse.

It is very interesting to find some specimens bearing elongate and more or less claviform corallites with the peculiar gemmation of *Lophohelia anthophyllites*, Ellis and Solander, on some portions of their stem, and the usual-shaped corallites of *Lophohelia prolifera* on others.

A separate corallum, which must be referred to *Lophohelia anthophyllites*, Ellis and Solander, was dredged up at No. 54.

The variation of the gemmules of several specimens is sufficiently great to absorb *Lophohelia subcostata*, Ed. & Haime; for fragments of the corallum of *Lophohelia prolifera* exist which possess all its so-called specific peculiarities.

A careful examination of *Lophohelia Defrancei*, Defrance, sp., from the Messinese Pliocene and Miocene deposits, and a comparison of its structure with the numerous specimens dredged up in the 'Porcupine' Expedition, lead me to believe that it is identical with *Lophohelia prolifera*.

The same identity must be asserted for *Lophohelia affinis*, Pourtales, which was dredged up in 195 fathoms off Coffin's Patches, Florida.

Lophohelia prolifera exists in the Mediterranean Sea and the sea between Scotland and Norway.

Lophohelia anthophyllites is an East-Indian form; but its absorption

* Seguenza, *l. c.*

into *Lophohelia prolifera* suggests explanations concerning the Cainozoic progenitor, and how it migrated eastwards.

The relation of the recent East-Indian Coral-faunas to those of the European and West-Indian Cainozoic deposits has been noticed and admitted for some years past.

The Cainozoic *Lophohelia* of Sicily is the earliest form of the genus; and those which are found in such remote parts of the world as the East Indies, the Florida coast, the Norwegian coast, and the Mediterranean, and which have been determined to belong to different species, are, from the study of the curious assemblage of variable forms now under consideration, evidently varieties of the old type, *Lophohelia prolifera*. I have therefore absorbed the old species *L. anthophyllites*, *L. subcostata*, *L. affinis*, *L. Defrancei*, and *L. gracilis*.

Two genera of the *Oculinidæ* in the classification of MM. Milne-Edwards and Jules Haime have always been most difficult to distinguish; and now the results of the dredging off the north of Scotland and off Florida and the Havana necessitate the absorption of one of them.

Amphihelia and *Diplohelia*.—The first containing recent species only at the time of the enunciation of the classification just referred to, and the last having fossil species only, were very likely to be considered separate genera. *Diplohelia* had species in the Eocene and in the Cainozoic seas. *Amphihelia* was known to have species in the Mediterranean fauna, and in that of Australia also. Seguenza, however, described some *Amphiheliæ* and *Diploheliæ* from the Sicilian tertiary deposits which were identical so far as generic attributes are considered, the only distinction being a doubtful raggedness of the septal edges. The habit and the method of growth and gemmation of the forms were the same. M. de Pourtales dredged up a branching form from off the Havana in 350 fathoms, and from off Bahia Honde, near Florida, in 324 fathoms, and also in lat. 28° 24′ N., long. 79° 13′ W., in 1050 fathoms (came up with the lead). This he named *Diplohelia profunda*. On referring to Seguenza's plates and descriptions* of the fossil corals from the Sicilian Tertiary deposits, there is no difficulty in deciding upon the very close affinity of the species described by Pourtales and *Diplohelia Meneghiniana*, Seg., and *Diplohelia Doderleiniana*, Seg., fossil forms from the mid-tertiary deposits.

But on comparing these forms with one exquisitely figured by Seguenza, and which he calls *Amphihelia miocenica*, Seg., the generic affinities of all become startlingly evident (tab. xii. fig. 1*b*, 1*c*, 3*b* & 3*c*, *op. cit.*).

The very numerous specimens of small branching *Oculinidæ* which were dredged up in the 'Porcupine' Expedition (No. 54, and to the north-west of that spot in the cold area), at a depth of from 363 to 600 fathoms, present singular variations of structure in the buds and calices upon the same stems. A comparison between them and the well-known recent and fossil *Amphiheliæ*, the fossil and recent

* Seguenza, *l. c.*

Diplohelicæ, and the smaller specimens of *Lophohelicæ*, leads to the belief that *Amphihelia* is identical generically with *Diplohelia*, and very closely allied to *Lophohelia*. Indeed the distinction between the *Lophohelicæ* and *Amphihelicæ* is of the slightest kind.

The species of the genus *Amphihelia* dredged up in the 'Porcupine' Expedition are five:—

1. Amphihelia (Diplohelia) profunda, *Pourtales*, sp.
2. —— oculata, *Linnæus*, sp.
3. —— miocenica, *Seguenza*.
4. —— atlantica, *nobis*.
5. —— ornata, *nobis*.

The species came from No. 54 dredging, and from the cold area to the north-west in from 500 to 600 fathoms.

The specimens are exceedingly beautiful, strong, and perfect; and there was much difficulty experienced in removing the polypes from the calices.

1. *Amphihelia profunda*, Pourtales, sp., has been noticed. It is a West-Indian form closely allied to a Sicilian miocene species.

2. *Amphihelia oculata*, Linnæus, sp., is well known in the Mediterranean, and has not hitherto been found in the Atlantic.

3. *Amphihelia miocenica*, Seguenza, is a very common species in the deep sea, but is rare in the miocene deposits of Sicily. Its fully developed costal structures distinguish it from the other forms.

4. *Amphihelia atlantica*, nobis, is a new species, large, bushy, and with almost plain cœnenchyma, which is very abundant.

5. *Amphihelia ornata*, nobis, is a new species closely allied to the miocene form, but its ornamentation is most peculiar, and not continuously costulate.

Allopora oculina, Ehrenberg.—Several specimens of this very rare coral were dredged up in No. 54, and one in the 'Lightning' Expedition, not far from the same spot.

The type is in the Berlin Museum; the locality whence it came is unknown.

The distinction between these massive and densely hard corals (whose calices are principally on one side of the cœnenchyma of the stem) and the *Stylasters* is very evident.

M. de Pourtales has described a pretty red-coloured *Allopora miniata* dredged in 100 to 324 fathoms off the Florida reef; but it is very distinct from the species discovered in the late deep-sea dredging expeditions.

Allopora has no fossil representatives.

Balanophyllia (*Thecopsammia*) *socialis*, Pourtales.—Six specimens of a simple perforate coral were dredged up in lat. 59° 56′ N., long. 6° 27′ W., 363 fathoms, temperature 31°·8 (No. 54), and one in lat. 61° 10′ N., long. 2° 21′ W., 345 fathoms, temp. 29°·9 (No. 65).

The six specimens are of different sizes and ages; and although they present considerable variation in shape and septal development, they evidently belong to one type. The solitary coral from No. 65 is larger than the others, but it belongs to the same species.

Notwithstanding the temperature in which the corals were found, and the depth of the sea, they are strong and well-developed forms, evidencing an active and abundant nutrition.

There is no difficulty in classifying the specimens with the *Thecopsammiæ* of Pourtales.

Thecopsammia socialis, Pourtales, was dredged up in from 100 to 300 fathoms, off Sombrero, near Florida, in the course of the Gulf-stream.

I have been able to compare the specimens dredged up in the 'Porcupine' Expedition with M. Pourtales's types, and, after making due allowance for variation, I have no doubt about including the British forms under his specific term. These varieties of the Floridan type, found at greater depths, and doubtless in much colder water, present evidences of greater vigour than the American forms. They are larger and denser, and their septa are better developed. Moreover some of them, although they possess all the other characteristics of the genus as diagnosed by Pourtales, present indubitable costæ, especially inferiorly. This clinging to the Balanophyllian type is not witnessed in the Floridan forms; but it is too important to be passed over, especially as it renders the generic distinction between many well-known *Balanophylliæ* and the new *Thecopsammiæ* very unstable. The *Thecopsammiæ*, from the peculiarities of their wall, epitheca, and septa, well merit the distinction of a subgenus; and therefore I propose to restore the species associated under the term to the genus *Balanophyllia*, in the subgenus *Thecopsammia*.

Balanophyllia (*Thecopsammia*) *socialis*, Pourtales, var. *costata*. No. 54, 'Porcupine' Expedition.

—— (——) ——, var. *britannica*. No. 54, 'Porcupine' Expedition.

—— (——) ——, var. *Jeffreysia*. No. 65.

All these varieties refer to specimens which were fixed by their bases to stones.

The varieties and the original types are very isolated forms in the great genus *Balanophyllia*. They have only a very remote affinity with the West-Indian recent *Balanophylliæ*, with those of the Crag, the Faluns, and the Eastern Tertiaries.

The British forms appear to have emigrated from the south-west; and probably the original type wandered through the agency of the Gulf-stream, which carried the ova and deposited them in our northern sea, where they have propagated, varied, and thriven.

Pliobothrus symmetricus, Pourtales.—A specimen of this doubtful coral (which had been described by M. de Pourtales from the results of dredging in from 100 to 200 fathoms) was sent to me by Dr. Carpenter. It came from the cold area, in from 500 to 600 fathoms.

There is no doubt that this very polyzoic-looking mass belongs to the American type. The tabulæ are hardly worthy to be called such; and I place the form amongst the Zoantharia provisionally.

III. The species of *Madreporaria* belong to genera which do not contribute and have not contributed to form coral-reef faunas. None of them are reef-builders; but all are essentially formed to live where rapid growth and delicately cellular structures are not required. The forms are strong, solid, and large; and their rapid and repeated gemmation proves that their nutritive processes went on actively and continuously.

All the species are very much disposed to produce variations; and this is especially true as regards those which have outlived the long age of the Crag, the glacial period, and the subsequent time of elevations and subsidences. The least-variable species are those which are not known on other areas.

Two of the three species which are common to the West-Indian deep-sea fauna and that of our north-western coasts are also very variable.

The persistence of *Madreporaria* from the earlier Cainozoic period to the present time has been an established fact for several years. Some of the forms which are common to the deep sea of the British area and to the so-called miocene of Sicily are still existing in the Mediterranean. None, however, of the species of Corals found in the British Crag are represented in the deep-sea fauna.

The existence of Mediterranean forms in the North-west British area is in keeping with the discoveries of Forbes. It has, however, a double significance, and bears upon the presence of West-Indian forms on the North-west British marine area. There was a community of species between the Mediterranean and the West Indies in the Cainozoic period, especially of Echinodermata, Mollusca, Madreporaria, and Foraminifera. After the great alterations of the mutual relations of land and sea which took place before the cold affected the fauna of the Franco-Italian seas, this community of species diminished; but it lasted through all the period of Northern glacialization, and is proved still to exist slightly by comparing the Algæ, the Corals, the Echinodermata, and the Mollusca.

The presence of two very characteristic Floridan species, and one less so, off the north of Scotland, is particularly interesting, because they all live in the cold area and flourish there, whilst they appear to be less vigorous in the warmer Gulf-stream near Florida.

It is impossible to fail to recognize the operation of this stream in producing the emigration of these three species, which are essentially American.

The solidity and the power of gemmation of the corals within the cold area appear to be greater than elsewhere. Depth has not much effect upon the nutrition of the *Madreporaria*; for those dredged up at 600 fathoms are quite as hard and solid as those found at 300 fathoms.

All the calices were stuffed with small Foraminifera, and there was evidently a great abundance of food.

There were numerous Polyzoa, Sponges, Foraminifera, Diatomaceæ, and delicate bivalves associated with or fixed upon the corals at all depths. Moreover, at from 300 to 400 fathoms, some *Amphihelicæ* had incrusted an Annelid.

Serpulæ, moreover, abound upon the corals; and a pretty *Isis* was associated with them at a depth of 705 fathoms. This is a fauna which, if covered up and presented to the palæontologist, would be, and would have been for some years past, considered a deep-sea one.

It is a fauna which indicates the existence of the same processes of nutrition and of destructive assimilation and reproduction which are recognized in association with corresponding forms at less depths and in higher temperatures.

The great lesson which it reads is, that vital processes can go on in certain animals at prodigious depths, and in much cold, quite as well as in less depths and in considerable heat. It suggests that a great number of the Invertebrata are not much affected by temperature, and that the supply of food is the most important matter in their economy.

The researches of Hooker, who obtained Polyzoa and Foraminifera in soundings at a depth of nearly 400 fathoms off the icy barrier of the South Pacific, of Wallich in the Atlantic, and of Alphonse Milne-Edwards in the Mediterranean have had much influence upon geological thought in this age, which, so far as geologists are concerned, is remarkably averse to theory. For many years before any very deep soundings had been taken with the view of searching the sea-bottom for life, geologists had more or less definite opinions concerning the deposition of organisms in sediments at great depths. Certainly more than thirty years ago deep-sea deposits were separated by geologists from those which they considered to have been formed in shallower seas. The finely divided sediment of strata containing Crinoids, Brachiopods, Foraminifera, and simple Madreporaria was supposed to have been deposited in deeper water than formations containing large pebbles, stones, and the mollusca whose representatives now live in shallows. The relations of such strata to each other during subsidence, the first being found occasionally to overlap the last, proved that there was a deeper sea fauna in the offing of the old shores which were tenanted by littoral and shallow-water species. The deposition of strata containing Foraminifera, Madreporaria, and Echinodermata, whose limestone is remarkably free from any foreign substances, has been considered to have taken place in very deep water; this theory has been founded upon the observations of the naturalist and mineralogist. Indeed no geologist has hesitated in assigning a great depth to the origin of some deposits in the Laurentian, Silurian, or in any other formation. The "flysch," a a great sediment of the Eocene formation, has been considered to have been formed at a great depth and under great pressure. Its singularly unfossiliferous character was supposed to be due to the absence of life at the depths of the ocean where the sediment collected. But this was a theory of the early days of geology, when the destructive influence of chemical processes in strata upon the remains of organisms in them was hardly admitted.

The great value of such researches as those so ably carried out by Thomson, Carpenter, and Jeffreys is the definite knowledge they impart to the geologist, who is theorizing in the right direction, but whose notions of the depth at which the sediments containing Invertebrata can be deposited are indefinite. These researches contribute to more exact knowledge, and they will materially assist the development of those hypotheses which are current amongst advanced geologists into fixed theories. I do not think that any geological theory worthy of the term, and which has originated from geological induction, will be upset by these careful investigations into the bathymetrical distribution of life and temperature. The theories involving pressure and the intensity of the hardness of deep-sea deposits will suffer from the researches; but many difficulties in the way of the palæontologist will be removed. The researches tend to explain the occurrence of a magnificent deep-sea coral-fauna in the Palæozoic times in high latitudes, and of Jurassic and Cainozoic faunas on the same area, and they favour the doctrines of uniformity. They explain the cosmopolitan nature of many organisms, past and present, which were credited with a deep-sea habitat, and they afford the foundations for a theory upon the world-wide distribution of many forms during every geological formation.

It is not advisable, however, to make too much of the interesting identities and resemblances of some of the deep-sea and abyssal forms with those of such periods as the Cretaceous, for instance. In the early days of geological science there was a favourite theory that at the expiration of a period the whole of the life of the globe was destroyed, and that at the commencement of the succeeding age a new creation took place. There were as many destructions and creations as periods; or, to use the words of an American geologist, there was a succession of platforms. This theory held back the science, just as the theory that the sun revolved round the earth retarded the progress of astronomy. Moreover it had that armour of sanctity to protect it which is so hard to pierce by the most reasonable opposition. Nevertheless every now and then a geologist recognized the same fossils in rocks which belonged to different periods. A magnificent essay by Edward Forbes on the Cretaceous Fossils of Southern India, a wonderful production and far before its age*, gave hope and confidence to the few palæontologists who began to assert that periods were perfectly artificial notions—that it did not follow, because one set of deposits was forming in one part of the world, others exactly corresponding to it elsewhere, so far as the organic remains are concerned, were contemporaneous—and that life had progressed on the globe continuously and without a break from the dawn of it to the present time.

The persistence of some species through great vertical ranges of strata, and the relation between the world-wide distribution of forms and this persistence were noticed by D'Archiac, De Verneuil, Forbes, and others. The identity of some species in the remote natural-history provinces of the existing state of things was established in spite of the dogmatic opposition of authorities; and then geologists accepted the theories that there were several natural-history provinces during every artificial period, that some species lived longer

* Quart. Journ. Geol. Soc. vol. i. p. 79.

and wandered more than others, and that some have lasted even from the Palæozoic age to the present.

Persistence of type was the title of a lecture delivered by Professor Huxley* many years ago; and this persistence has been admitted by every palæontologist who has had the opportunity of examining large series of fossils from every formation from all parts of the world.

Geological ages are characterized by a number of organisms which are not found in others, and by the grouping of numerous species which are allied to those of preceding and succeeding times, but which are not identical. Certain portions of the world's surface were tenanted by particular groups of forms during every geological age; and there was a similarity of arrangement in this grouping under the same external physical conditions. To use Huxley's term, the "homotaxis" of certain natural-history provinces during the successive geological ages has been very exact. The species differed: but there was a philosophy in the consecutive arrangements of high-land and low-land faunas and floras, and of those of shallow seas, deep seas, oceans, and reef-areas. The oceanic† conditions, for instance, can be traced by organic remains from the Laurentian to the present time, and the deep-sea corals now under consideration are representative of those of older deep seas.

It is not a matter for surprise, then, that, there being such a thing as persistence of type and of species, some very old forms should have lived on through the ages whilst their surroundings were changed over and over again. But this persistence does not indicate that there have not been sufficient physical and biological changes during its lasting to alter the face of all things enough to give geologists the right of asserting the succession of several periods. The occurrence of early Cainozoic Madreporaria in the deep sea to the north-west of Great Britain only proves that certain forms of life have persisted during the vast changes in the physical geography of the world which were initiated by the upheaval of the Alps, the Himalayas, and large masses of the Andes. To say that we are therefore still in the Cainozoic or Cretaceous age would hardly be consistent with the necessary terminology of geological science.

During the end of the Miocene age and the whole of the Pliocene the Sicilian area was occupied by a deep sea. The distinction between the faunas of those times and the present becomes less, year after year, as science progresses; and it is evident that a great number of existing species of nearly every class flourished before the occurrence of the great changes in physical geology which have become the artificial breaks of tertiary geologists. That the Cainozoic deep-sea corals should resemble, and in some instances should be identical in species with, the forms now inhabiting vast depths, is therefore quite in accordance with the philosophy of modern geology. Before the deposition of the Cainozoic strata, and whilst the deep-sea deposits of the Eocene age were collecting in the Franco-British

* Royal Institution. See also Pres. Address, Geol. Soc., 1870.

† P. M. Duncan, Quart. Journ. Geol. Soc. No. 101.

area, there was a Madreporarian fauna there which was singularly like unto that which followed it, both as regards the shape of the forms and their genera. Still earlier, during the slow subsidence of the great Upper Cretaceous deep-sea area, there was a coral-fauna in the north and west of Europe, of which the existing is very representative. The simple forms predominate in both faunas. *Caryophyllia* is a dominant genus in either; and a branching *Synhelia* of the old fauna is replaced in the present state of things by a branching *Lophohelia*. The similarity of deep-sea coral-faunas might be carried still further back in the world's history; but it must be enough for my purpose to assert the representative character and the homotaxis of the Upper Cretaceous, the Tertiary, and the existing deep-sea coral-faunas. This character is enhanced by the persistence of types; but still the representative faunas are separable by vast intervals of time.

MISCELLANEOUS.

On Parthenogenesis in Polistes gallica. By Prof. C. T. von Siebold.

As long ago as 1858, Leuckart ascertained that the workers in societies of humble bees and wasps lay eggs, and that these eggs are capable of development. Von Siebold has resumed these experiments upon *Polistes gallica*. This wasp is peculiarly suitable for such investigations, because its nest consists of a single comb entirely exposed. The comparative imperfectness of this nest allows the observer to follow all the actions of its inhabitants and all the phenomena which take place in its cells. Von Siebold succeeded in fixing great numbers of colonies of *Polistes* in places selected by him. He even succeeded in making these nests moveable for the purpose of experiment, without causing their inhabitants to abandon them. In this way he was able to observe hundreds of colonies of *Polistes* from their origin to their extinction.

One nest of *Polistes* suffices for an entire summer for a colony, which it serves as a habitation and nursery. In the autumn all the colonies perish, however numerous they may be. Every spring isolated females give origin, each for itself, to new colonies. These females were produced during the previous summer, which they passed in a virgin state, and were fecundated by copulation in the autumn before falling into their winter sleep. The spermatozoids stored in the seminal receptacle are preserved in good condition throughout the winter, and in spring fertilize the eggs as the deposition of the latter goes on. Each of these females constructs for itself a nest composed of a small number of cells, and busies itself at first with oviposition, and then with the bringing up of the new generation. The new individuals thus engendered are, up to the middle of summer, exclusively females. The first of these individuals, reared by isolated mothers, are females of very small size. Their smallness is no doubt due to the circumstance that the mother, being overwhelmed with work, can only furnish her young with a scanty supply of nourishment. These small individuals have hitherto been regarded as workers or neuters; but this denomination is erroneous. Von Siebold has dissected many of these small individuals of *Polistes*, and ascertained, by the examination of their generative apparatus, that they are not, like the worker bees, females arrested in their development, but perfectly developed females the turgid ovaries of which are filled with eggs ready to be laid.

As soon as the original mothers have thus produced assistants in the form of these active virgins, the increase of the nest takes place rapidly, and the larvæ, receiving more abundant nourishment, are transformed into wasps as large as their mother. Towards the end of June or the beginning of July the comb presents a large surface and is composed of a very great number of cells. At this period some male individuals may be remarked for the first time among the numerous large and small females. Their number soon increases considerably. The observation of these facts suggested to Von Siebold that there might exist, in *Polistes*, a division of physiological labour—in this sense, that the fecundated females of the preceding year produce only female eggs, whilst the virgins of the new generation produce male eggs parthenogenetically. This hypothesis seemed to find support in the small number of ovarian tubes in *Polistes*, which can only produce an inconsiderable number of eggs.

Experiment has confirmed this hypothesis in the most striking manner. Von Siebold selected a certain number of nests in the spring, at a period when the mothers had already reared one or two assistants. He removed from these nests the mothers, and dissected them in order to ascertain the condition of their generative organs. He always found the ovarian tubes in full activity, and the seminal receptacle full of mobile spermatozoids. At the same time he entirely emptied all the cells of these nests which contained eggs or any small larvæ, preserving only the larvæ of large size. Notwithstanding the disappearance of the mothers, the little virgins continued to take care of the larvæ which had been preserved, and consequently the colonies did not perish. Von Siebold took the precaution to mark, in each of the nests experimented upon, the occupied and empty cells. In a few days he perceived that some of the latter contained eggs. Careful examination even enabled him to surprise some of the little virgin wasps at the moment when they were ovipositing at the bottom of a cell. These individuals were at once sacrificed, when the six ovarian tubes were found to be completely developed, filled with ova in different stages of growth, whilst the seminal receptacle was perfectly formed but completely empty.

During this time, thanks to the assiduous care of the young virgins, new female individuals, produced from the large larvæ which had not been sacrificed, arrived at their complete development, and at once took part in the labours of the society. The nests were consequently enlarged by new cells, which were speedily occupied by eggs laid by the virgins. All these eggs (and this is the important fact) were developed notwithstanding the absence of fecundation, and gave birth to young larvæ which prospered under the care of the virgin society. All these larvæ, at their final transformation, furnished males, in opposition to the larvæ which had been previously produced by the original mother, and which had furnished only females.

It may, perhaps, be asked whether a strange fecundated mother may not have penetrated accidentally into the nests deprived of their mother, and oviposited here and there in the cells. To this question Von Siebold gives a decided negative. During the four years which he has devoted to the study of these wasps, he has constantly ascertained that the inhabitants of one nest never tolerate the intrusion of a *Polistes* from another colony into their society. The instinct of these Hymenoptera informs them that these intruders are only robbers penetrating into their nest to steal the larvæ and devour them. It is therefore evident that in *Polistes gallica* the male individuals originate parthenogenetically from unfecundated eggs.—*Zeitschr. für wiss. Zoologie*, Bd. xx. p. 236; *Bibl. Univ.* March 15, 1870, *Bull. Sci.* p. 271.

On Force and Will. By B. A. Gould.

Scientists are now of accord that " force can neither be created nor destroyed," and that " the quantity of force in nature is just as eternal and unalterable as the quantity of matter." Its various forms are eminently convertible, yet utterly indestructible. And to avoid that fruitful source of disagreement among the ablest men, which has arisen from the ambiguous signification of the word, we must adopt the meaning which is finding general acceptance, and define force as " that which is expended in producing or resisting motion "—thus clearly discriminating between force and its cause.

In his retiring address before the American Association last year, our honoured ex-president Dr. Barnard presented an argument, so vigorous and clear that I see no room for an adequate rejoinder, in opposition to the doctrine which would extend the principle of the conservation of force to the phenomena of consciousness—" a philosophy which at the present day is boldly taught in public schools of science, and which numbers among its disciples many very able men." He says, for instance :—

" Organic changes are physical effects, and may be received without hesitation as the representative equivalents of physical forces expended. But sensation, will, emotion, passion, thought are in no conceivable sense physical " (Proc. Amer. Assoc. Chicago, p. 89).

" The philosophy which makes thought a form of force, makes thought a mode of motion, converts the thinking being into a mechanical automaton, whose sensations, emotions, intellections are mere vibrations produced in its material substance by the play of physical forces, and whose conscious existence must for ever cease when the exhausted organism shall at length fail to respond to these external impulses " (ibid. p. 91).

" Thought cannot be physical force, because it admits of no measure. * * A thing unsusceptible of measure cannot be a quantity; and a thing that is not even a quantity cannot be a force" (ibid. pp. 93, 94).

Before the cogent reasoning carried out by President Barnard, of which the general tenor is indicated by these quotations, the view that force affords a middle term between the moral and the material worlds can be sustained as little as the pure materialism against which the argument was directed. But if we ascend a grade higher, and consider that which guides and compels force, as force guides matter, I am disposed to believe that the problem may be nearer to a solution. Yet I offer my views with hesitation, not unmindful of the great thinkers who have considered these exalted topics, and shrinking from the rebuke of presumption.

There is an elegant experiment, in which the tension of a spring is made to produce heat by percussion, thus developing the current from a thermo-electric battery, which by successive modifications of its force exhibits heat, chemical action, magnetic attraction, and finally bends another spring—the same original force successively appearing in all these various manifestations until it is reestablished in its primitive form. In such an experiment the imperfections of the apparatus would of course entail some loss at each successive step, and thus preclude the practical recovery of an available force equal to that expended in the original flexure of the spring. Yet the fact is beyond question that such loss is due solely to the inadequacy of our implements for collecting and transmitting the force at each stage of the experiment; for the law of conservation teaches that it is in every instance converted into other form or forms without diminution. Could such an apparatus be constructed with theoretical perfection, it would represent an eternal circuit of force; and, like the frictionless pendulum in a vacuum, it would exhibit a perpetual motion, after the needful impulse had once been applied. The spring would oscillate for ever, did no extraneous force oppose, whether the force producing its rebound were or were not transmitted through a chain of modifications.

In this inert apparatus no force whatever would have been imbodied; yet qualities would have been implanted by design, which would compel an indestructible force applied to it to play the part of an unwilling Proteus. The inference seems unavoidable that force may be guided and controlled, compelled to exert itself in this or that shape, without the outlay of any other force for the purpose. If it be objected that it is an intrinsic law of force that it shall change its form in exerting itself, the case is in no wise altered by the expression of this truism. Our design has prescribed, and (extraneous force being absent) might indefinitely prescribe, the modes and directions in which that constant force should manifest itself.

Muscular force is directed, and in its vital action is usually controlled, by will. If we assume it to be coequal with the expenditure of tissue *, measurable alike by its transferred results and by the

* Even if it be also, to some extent, supplied by the disorganization of food not fully converted, the argument is not thereby affected.

decomposition of this tissue, where and what is that power which lets loose or withholds this force, and whose action is attended by a conscious effort? It is the will—a something which directs and controls force without expending it. Not only are thought and forms of consciousness not forces, if the reasoning already adduced be correct, but, although often moral incentives to the will, they are not even motive energies in the sense in which I think we must concede the will to be such. It is true that the exercise of thought is followed by fatigue, yet it is not attended by a sense of effort, except in so far as it is directed by an exertion of the will. And although the former doubtless consumes tissue, have we any reason for believing that the exercise of will does the same, apart from that consumption which corresponds to the forces whose mode of action it prescribes?

Thus it would appear that the metamorphosis of force, though not "work done" in the mechanical sense, is the result of some definite mode of causation. What this causation is, and whether it is susceptible of measurement, are the next questions. In the same category with this agency, or energy, or influence, the vital principle would seem to belong—directing forces while it neither expends nor consumes them. In the growth of organic beings, unstable combinations are formed; and organized structures are thence reared, in which, as Kant has so beautifully said, "all parts are mutually ends and means." If in such organic development force is consumed, disorganization without decomposition ought to evolve it. Of the deposit of force in the unstable material of the tissues I am not speaking, but of the vitality itself, which represents an energy requisite for the development and growth of organisms, their dissolution being in turn attended by development of inferior forms of life, which suggest that this energy may have again been made available—an energy, too, which is not "force" as this term has just now been defined.

No comparison can be drawn between vitality and those molecular forces which build the crystal. Crystalline forms arise when the molecular attractions enjoy the freest scope; and their construction must be attended by an evolution of force which ought to be recognizable by physical tests, and which should also be measurable by an excess of their resistance to solution, over that of comparatively amorphous masses of the same material, in which equal weights present equal surfaces.

So, too, not only in that individuality which life confers and in the impossibility of insulating or transferring vitality, but also in its hereditary character and its apparent susceptibility of indefinite increase or diminution, the vital energy violates our fundamental conceptions of force, and demands a separate category, seeming to belong in the same with will. If will and life be forms of force, their total amount must be limited by the law of conservation. If, on the other hand, they are outside the realm of forces, we may more readily indulge the conviction to which experience would lead, that their freedom is unfettered by any restrictions within our knowledge, each enjoying an indefinite, though possibly a correlated scope in its own domain. The indestructibility of both matter and force implies a fixed coefficient of force for matter in equilibrium; but how great is the contrast offered in this respect by such energies as life and will!

Now, if this reasoning be correct, we may have in this class of energies that middle term, so earnestly desired and so intensely needful, which unites the phenomena of matter with those of spirit, and forms the connecting link between science and religion, their harmonious conjunction affording the highest system of philosophy. It is this class of energies which, controlling the forces of matter, guides and governs their modifications and transformations. It is this, moreover, which, inseparable from mind, is exerted by all conscious organism. The mystic play of coequal, but, to our senses, so dissimilar forces, and the equally recondite mutual action of the eye, the brain, and the nerve, alike demand agencies transcending all our science, yet implicitly obeying physical laws. The highest manifestation of these agencies is in will; the highest agent is the Almighty. Thus the dictum of faith, that the universe exists only by virtue of the continued will of its Creator, represents a palpable scientific fact; and we may see that the pantheist, the materialist, and the spiritualist (I will not be debarred from this noble word by the associations of its misuse to-day) have been contemplating the same exalted truth from different aspects, with limited ranges of vision.—*Silliman's American Journal*, March 1870.

On the Constitution and Mode of Formation of the Ovum of the Sacculinæ. By M. Balbiani.

In a note inserted in the 'Comptes Rendus' of the 29th November last, M. E. van Beneden undertook to show that the interpretation given by M. Gerbe to the facts observed by him in his investigation of the mode of formation of the ovum of the *Sacculinæ* is incorrect. At the same time he presents a very different explanation of these facts, and he concludes by rejecting as unfounded the inductions which M. Gerbe had drawn from his observations with regard to the constitution of the ovum in a great number of animals. In his memoir M. E. van Beneden also criticizes the opinions that I have put forward as to the nature and physiological function of the peculiar body first seen in the ova of certain spiders by some German observers, and which I subsequently made the subject of a special memoir, presented to the Academy in 1864. I shall endeavour to reply hereafter to those of M. E. van Beneden's assertions which concern me; but in the meantime it is not without interest to inquire which, M. Gerbe or M. van Beneden, is in the right in the explanation proposed by him of the facts observed by him in the *Sacculinæ*.

Let us first recall in a few words the manner in which these facts were detailed by M. Gerbe. According to this observer the ovum of the *Sacculinæ* is constructed upon a type analogous to that of Birds: that is to say, it is composed of a nutritive part, or yelk, and a plastic part, or cicatricula. According to him, this structure is manifest especially in the young ovules, which even appear as if composed of two distinct halves or lobes separated by a median constriction, of which one represents the primitive yelk, the other the germinative portion. Afterwards the latter is no longer visible, except in the form of a small rounded prominence on the surface of the mature ovum. The yelk and the cicatricula each bear at the centre of formation a separate vesicle, such as I had myself previously assumed for the ova of a considerable number of animals; but, reversing the parts ascribed by me to each of these two constituent elements of the ovule, M. Gerbe regards the vesicle placed at the centre of the cicatricula as corresponding to the germinal vesicle of other species of animals, and that situated in the midst of the yelk as the homologue of the second vesicle which I have indicated in the vitelline nucleus of the Arachnida, Myriopoda, &c.

When M. Gerbe published these results I thought it necessary to raise some objections to his views; but not having then any personal knowledge of the facts upon which he based them, I confined myself to showing that his observations had not the precision necessary to justify the general conclusions which M. Gerbe drew from them with regard to the function of the two primitive vesicles of the ovum. I have since acquired more decisive proofs, having had the opportunity, during a recent residence on the coast, of undertaking some researches on my own account into the mode of formation of the ovum in the *Sacculinæ*. I have observed all the interesting facts to which M. Gerbe first called the attention of naturalists; but, like M. van Beneden, I am obliged to interpret them quite differently from the able naturalist of the College of France. On the contrary, my observations agree in almost all points with those of M. van Beneden, although made quite independently. This will appear clearly from the following *résumé* of my investigation of *Peltogaster Paguri* (Rathke).

Let us first examine the facts observed in the little Naupliiform larvæ which represent the first age of the animal at its escape from the egg. When observed in an uninjured state, we only see in their interior a mixture of refractive globules, the remains of the nutritive vitellus, and of larger bodies, refracting light much more feebly, and having all the characters of true cells. But on bursting the outer integument of the larva by careful pressure, the contents escape, and we see that these cells are rudimentary ova attached by a prolongation, in the form of a peduncle, to a slender central cord, a sort of rachis, on the surface of which the ovules originate by budding. This structure of the ovary of the larva of *Peltogaster* greatly reminds one of that of the same organ in the Arachnida. The ovules are pyriform; the largest have an average diameter of 0·025 millim.; whilst the smallest appear as almost imperceptible grains attached to the surface of the rachis. Nothing in the constitution of these bodies recalls the organization which M. Gerbe ascribes to them in the adult *Sacculina*. The ovules, in the larva, at least during the first period which follows the exclusion of the latter, evidently only represent simple cells with their ordinary constituent parts—namely, a protoplasm which is sometimes homogeneous, sometimes more or less granular, according to the state of development, and a nucleus or germinal vesicle, 0·014 millim. in breadth in the most advanced ovules, and furnished with a single nucleolus or germinal spot, which is comparatively large and well marked. Moreover by means of reagents we may display an enveloping membrane surrounding the ovules; but this appears to me to be rather a capsular envelope than a real vitelline membrane. What are the modifications undergone by the reproductive apparatus during the successive phases through which the larva passes before commencing its sedentary and parasitic existence? My investigations have taught me nothing about this; for I have not been able to meet with the larva again until, fixed upon the abdomen of the *Pagurus*, it had become transformed into the adult animal, a sort of pouch filled with eggs, in which the latter pass through all the stages of their ovarian and embryonal evolution. At this period of their life the ovarian rachis of the larva has become transformed into a ramose organ, the numerous divisions of which serve to support a multitude of ovigerous follicles, which are appended to it as the grapes of a bunch are to its ramifications. When the ovary is torn under water, the elements enclosed in the ovigerous follicles are set free. These are, in the first place, some spherical bodies rendered opaque by the numerous refractive globules contained in their interior; these are easily recognized as ova more or less approaching their period of maturation. Their diameter varies between 0·13 and 0·15 millim. We shall revert hereafter to the constitution of these bodies. Side by side with them we see a great number of other smaller elements, as to the signification of which we may at first hesitate. Some of them are regularly round cells, 0·02–0·03 millim. in breadth, formed of a transparent, finely granular protoplasm, with a nucleus 0·015 millim. in diameter, furnished with a simple, large and rounded, very refractive nucleolus. The others have a bilobed form, and appear, at the first glance, to be constituted by the adhesion of two of the preceding cells; but a more careful examination soon shows that they are merely a state of division of the latter.

Thus we see all the forms intermediate between the simple cells and the bilobed bodies, namely:—cells still regularly spherical, but already enclosing two juxtaposed nuclei; others which begin to exhibit a median constriction of their body, with a tendency on the part of the two nuclei to separate from each other; others, finally, in which the two new cells are already well defined, but remain adherent by a larger or smaller part of their surface.

In these last elements we readily recognize the *bilobed ovules* of M. Gerbe, or the *mother cells* in their different states of division described by M. van Beneden. I have but little to add to the description given of them by this latter observer. The two daughter cells are not at first separated by any intermediate membrane, and their protoplasm is directly continuous; so that, looking at things only by their first appearance, M. Gerbe might really be justified in thinking that he had under his eyes a small ovum with two lobes, each containing a vesicular nucleus in a common vitelline mass. But the illusion is no longer possible when these bodies have passed to a more advanced stage. In fact a transverse membranous septum is soon formed between the two adherent daughter cells, and separates their contents. This septum is visibly continuous with the line of the outer contour of the two cells, and consequently cannot be interpreted otherwise than as an internal prolongation of the enveloping membrane, which was originally common to them. Thus I cannot share in the opinion of M. van Beneden, who denies a cell-membrane to the young ovules. It is by means of this median septum, which, instead of splitting, and thus permitting the separation of the two ovules, remains simple, that the latter are, so to speak, soldered together. This splitting only takes place much later, when one of the two united cells, having alone continued its development, becomes transformed into a mature ovum, as described by M. van Beneden. We still see, for a longer or shorter time, at the surface of this ovum, the ovule which has remained stationary in its development in the form of a small rounded prominence; but this is detached when the ovum quits its follicle to pass into the oviferous pouch. It was by following the gradual development of this ovum that M. van Beneden ascertained that the supposed cicatricula with which M. Gerbe had endowed it was nothing but the little sister cell adhering to it, and that the cellular nucleus which the same observer supposed to exist at the centre of this cicatricula was only the nucleus of this same cell. We arrive at a similar demonstration by the mechanical means which enable us to separate these two bodies. Thus by rolling the ovum carefully under a thin glass cover, we sometimes succeed in detaching from it the little ovule, which, as soon as it is free, resumes its original spheroidal form. The same result is also sometimes obtained by the action of chemical substances, which cause the contraction of the protoplasm, by the tendency of the little ovule to acquire a rounded form under the influence of those reagents.—*Comptes Rendus*, December 20, 1869, tome lxix. pp. 1320–1324.

On some Mammalia from Eastern Thibet. By M. A. Milne-Edwards.

Two monkeys inhabit the coldest and least accessible forests of eastern Thibet. One is a *Macacus*, allied to *M. speciosus* and *M. tcheliensis*, in which the tail is very short. Its coat is of a dark greyish brown; the hairs, which are very long and thick, present no differently coloured bands; the lower parts of the body are of a much lighter grey, and the face and hands are flesh-coloured. The species is named *M. thibetanus*.

The second species is a *Semnopithecus*, named *S. roxellana* by the author. It is distinguished by its very long and thick coat, the hairs of which are grey at their base and silvery yellow towards the point; the latter colour predominates on the limbs, the belly, and the sides of the face, and is mingled with a very brilliant red tinge on the frontal region. The upper margin of the nostrils is much developed, forming a true nose.

Two species of Insectivora form the types of new genera. One of these seems to be a transition form between the Desmans and the Shrews; like the former it has the posterior feet dilated into natatory pallets, and its tail is long and laterally compressed; but its snout is short, and its teeth resemble those of *Sorex*. It has sixteen teeth in the upper and twelve in the lower jaw. To this animal the author gives the name of *Nectogale elegans*. The second form is nearly allied to the Shrews, but is distinguished by having scaly feet and a tail so short as to be concealed by the hairs; it has only twenty-four teeth, twelve above and twelve below. For this genus the author proposes the name of *Anourosorex*. A mole, named *Talpa longirostris*, is characterized by its very elongated muzzle, which gives it a certain resemblance to the Japanese *T. moogura*. The latter has only six inferior incisors; the new Thibetan species has eight.

The most interesting animal is one called by the Abbé David *Ursus melanoleucus*. The author states that it is not a bear, although resembling one in its external appearance, but in its osteological and dentary characters it approaches the Pandas (*Ailurus*) and Raccoons. It forms a new genus, for which the name of *Ailuropoda* is proposed. The author also notices a fine Flying Squirrel, which has the head and breast covered with a mixture of bright-red and white hairs. He names it *Pteromys alborufus*.—*Comptes Rendus*, February 14, 1870, tome lxx. pp. 341–342.

On the Transformation of the Nests of the House-Martin (Hirundo urbica, *Linn.*). By M. A. Pouchet.

M. Pouchet has noticed a change in the design of the nests of the common House-Martin, which he says has been effected within the last forty years, and the observation of which leads him to think that the notion of the exact persistence of the same mode of nest-building is by no means so certain as has generally been supposed. He refers to several instances in which we may presume that a change took place on the birds of certain species quitting the open country and coming to take up their abode among human habitations.

With regard to the House-Martin, M. Pouchet states that, having procured some nests in order to draw them, he was surprised to find that they differed considerably from those which he had collected forty years ago, and which are still preserved in the Museum at Rouen. A reference to published figures of the Martin's nest furnished further evidence of the same kind.

The nests of the older form are hollow quarters of hemispheres applied by three sections to the embrasures of windows or to the surface of buildings, and having *a very small circular opening*, two or three centimetres in diameter, for the entrance and exit of the birds. The new nests, on the contrary, represent the quarter of a hollow hemiovoid, having its poles much elongated, and its three sections adhering to the walls of buildings, except above, where the entrance is formed; and this entrance, instead of being a mere rounded hole, *is a long transverse fissure* bounded below by a depression of the margin of the nest, and above by a projection of the building to which the nest is attached. This aperture is nine or ten centimetres in length, whilst its gape is only two centimetres.

M. Pouchet regards this alteration in the form of the nest as not only a change, but an improvement. The greater extent of the floor gives more room for the movements of the little family, the members of which will be less heaped upon one another. The long narrow aperture enables the young birds to put out their heads so as to breathe the fresh air and contemplate the world around them, whilst the access of the parent birds to the nest without displacing the young ones is rendered far more easy, and the interior of the nest is better protected from the weather.

His attention having been called to this change in the structure of the Martins' nests, M. Pouchet set to work to examine with a glass the nests in position in various parts of Rouen. He found that upon the old churches of the centre of the town many of the nests presented the old construction, being either old nests repaired and made fit for use, or the work of conservative architects who still stuck to the old plan: the former appeared to M. Pouchet to be the most probable supposition. Mixed with these were other nests of the new form. Along the new streets of Rouen, on the other hand, all the nests were built after the new fashion.—*Comptes Rendus*, March 7, 1870, tome lxx. pp. 492–496.

Character of a new Species of Crossoptilon. By the Abbé Armand David.

M. Milne-Edwards has communicated to the Academy of Sciences the following diagnosis of a *Crossoptilon*, extracted from a letter of M. A. David, dated Sse-Tchuan, December 18, 1869. The species is named *C. cærulescens*:—

"Same dimensions and form as *C. auritum*; feet red; bill light red, marked with brown towards the tip; iris reddish nut-brown; head like that of the species from Pekin, with the elongated feathers of the ears a little more developed; general colour of the plumage a uniform and very fine *dark-bluish slate-colour*, except that the ends of the large feathers of the tail are black and shining, with green and violet reflections; the three or four small lateral feathers are white at their basal portion or entirely, according to age; the large quill-feathers of the wings also are olive-coloured; and the black velvety feathers of the top of the head are separated from the slate-coloured feathers of the neck by a small white streak."—*Comptes Rendus*, March 7, 1870, tome lxx. p. 538.

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XXXIII.—*On two new Species of the Foraminiferous Genus* Squamulina; *and on a new Species of* Difflugia. By H. J. Carter, F.R.S. &c.

[Plates IV. & V.]

The genus *Squamulina*, according to Dr. Carpenter, was instituted by Prof. Schultze (Ueber den Organismus der Polythalamien, &c., 1854) for "a minute Monothalamion of which he found several specimens at Ancona, adhering to the surface of Algæ and to the sides of a glass vessel in which sea-water had been long kept. The shell, whose largest diameter is about 1-300th of an inch, has the form of an irregular plano-convex lens, being usually flat, or nearly so, on its attached side (which accommodates itself to the surface whereon it grows) and convex on its free side, on some part of which, usually about halfway between the centre and the periphery, is a wide orifice from which the pseudopodia issue. The shell is calcareous and opaque, and is destitute of pores; its adherent layer is very thin, and is with difficulty detached from the surface to which it is attached. The substance of the animal is of a brownish-yellow colour, as in *Gromia*; its pseudopodia, however, seem fewer and less disposed to subdivide and inosculate." (Carpenter, 'Introduction to the Study of the Foraminifera,' Ray Soc. Pub., p. 67, pl. 1. fig. 22; also Pritchard, 'Infusoria,' p. 558, ed. 1861.)

Two arenaceous forms of this genus live in the laminarian zone at Budleigh-Salterton, as their presence on certain fuci cast upon the beach during storms indicates:—one like *Squamulina lævis*, the type species of Schultze's genus just described; the other, also discoidal, but bearing a little, erect, brush-like eminence on its convexity.

For the former I would suggest the specific name *varians*, and for the latter *scopula*, from the resemblance of the eminence to a little brush or broom.

Let us direct our attention to a description of the latter first, as being the most interesting form of the two species.

Squamulina scopula, mihi. Pl. IV. figs. 1–11.

Test white and hollow, consisting of a pedestal (fig. 3 *a*) and columnar portion (*bbb*), the former plano-convex and the latter obversely conical, terminating in a brush-like bunch of spicules (*ff*). Pedestal subcircular, more or less raised, closed below by a discoidal portion, which, stretching across its base, forms the point of attachment between the animal and the fucus or object on which it may be located; open above, where it joins the pointed end of the columnar portion. Columnar portion erect, conical, with the pointed end downwards, consisting of a neck (*d*), body (*c*), and head (*e*); neck contracted, more or less ligamentous, connecting the lower extremity of the column with the summit of the pedestal; body increasing in size upwards, and formed of two or more dilatations; head inflated, and bristled all over with sponge-spicules. The whole composed of fragments of hyaline colourless quartz, mixed with sponge-spicules and a small portion of calcareous matter, cemented together by a chitinous substance; tessellated and almost smooth below, becoming rougher upwards, until the whole head is obscured by a heterogeneous mass of projecting spicules and other like bodies, obtained indiscriminately from all the sponges of the locality, both siliceous and calcareous, arranged in a spreading form obliquely forwards, not unlike the fibres of a little broom, whence its specific designation—but where the spicules are capitate and not pointed at each end, having the heads *outwards*; grains of quartz, for the most part, so minute and numerous that, like pounded glass, they cause the test to present a white colour when dry, which, of course, becomes greyish in water. Chitinous substance or basal cement supporting the arenaceous particles of the test outside, and inside forming a smooth surface, which lines the chambered cavity of both pedestal and column; thickest, and even fibrous, about the lower end of the column, where it connects the latter with the summit of the pedestal, and where (if not always, for a minute distance) it, in many instances, is uncovered by the arenaceous coat (fig. 4 *a*), obviously for giving that latitude of movement to the column upon the pedestal which enables the former, when fresh or wet, to be bent down almost at right angles to the pedestal without breaking (fig. 2 *a*), but, on the contrary, with the power of regaining its erect position by the resilient nature of the chitine, here presenting a fibrous structure, perhaps in the living state under the command of some contractile contrivance obeying the instinct of the animal. Pedestal hollow, presenting septal prolongations of the arenaceous coat inwards from its circumference towards the centre, which they seldom if ever reach, but, extending upwards from the disk, along the dome of the convexity, lose themselves at last in the latter as they approach the round hole leading from its summit into the columnar portion (figs. 5–9). Columnar portion hollow, consisting of two or more chambers corresponding with the number of its dilatations (*i i i*), bound together by isthmic contractions, the last of which terminates in an aperture (*k*), about 4-6000ths of an inch in diameter, at the free end of the column, in the centre of the brush of sponge-spicules. Animal occupying the cavity of the test, consisting of semitransparent yellowish sarcode (fig. 11 *a*) charged with granules and oil-globules (*b b*), frustules of Diatomaceæ, especially *Melosira* (*d*), dark-brown bits of fucus, and reproductive cells (*c*); more attenuated and less coloured anteriorly, whence the pseudopodia are projected; bearing the frustules of Diatomaceæ and bits of fucus in the centre; and posteriorly charged with a great number of the reproductive cells, consisting of spherical, transparent, nucleated capsules, otherwise filled with a homogeneous, glairy, albuminous (?) substance. Largest test about 1-12th of an inch long; reproductive cells about 2½-6000ths of an inch in diameter.

Hab. Sea: Laminarian zone; fixed on the purse-like root of *Laminaria bulbosa*, chiefly on and among the rootlets, also on the fronds of *Phyllophora rubens.* Often in company, on the former, with *Squamulina varians*, *Leucosolenia botryoides*, and *Grantia ciliata.*

Loc. Beach at Budleigh-Salterton, Devonshire; cast ashore by storms.

Obs. We are indebted to Dr. Bowerbank for the first description and illustration of this little organism (Phil. Trans. 1862, p. 1105, pl. 73. fig. 3; repeated in 'Brit. Sponges,' Ray Soc. Pub. 1864, vol. ii. p. 78, pl. 30. fig. 359), who gave it the name of "*Halyphysema Tumanowiczii*," adding that "it is remarkable for being the smallest British Sponge" (!). But, as mental operations are seldom so correct as visual ones, so our author, who figures the polypes on the cord of *Hyalonema* as "oscula" (Brit. Spong. vol. i. p. 287, pl. 35. fig. 374), has, in 1864, also very imperfectly figured this little Foraminiferous animal "as the smallest of British Sponges," for which Schultze had already instituted the genus "*Squamulina*," ten years previously, viz. in 1854 (*op. cit.*). I do not, therefore, hesitate to use Schultze's generic name with a new specific one of my own, in order that henceforth all connecting *Squamulina scopula* with the sponges may be abandoned. How Dr. Bowerbank could have placed it among the sponges, when he states that he was unable "to detect either oscula or pores," and observed that the "globular heads" of the spicules were outwards (*op. cit.*), I am at a loss to conceive. At the same time this mistake points out to us how very careful we should be when we come to the nice distinctions that exist between the Foraminifera and the Sponges, especially in the minuter forms, where deciding upon mere resemblances is as dangerous as denying the presence of pores or oscula in either class where we cannot immediately see them with our microscopes.

I first found *Squamulina scopula*, on *Phyllophora rubens*, in November last (1869), and, after drying the specimens for examination with the microscope, was struck with the septated appearance of the bottom or discoidal part of the pedestal, which generally adheres to the fucus when the test is broken off in the dried state—an appearance so like the septal divisions of a coral-polype that I began to think that the organism must in some way be allied to these animals.

Resolved, therefore, to take the earliest opportunity of further prosecuting this inquiry, I in vain sought for more specimens of this little organism on pieces of *Phyllophora*; and, seeing the ordeal to which they must be exposed in passing through the "hurly-burly" of pebbles, waves, and sand, before they could reach the shore in safety, I had nearly given up all idea of success, when, one day in January last, I discovered it on fresh specimens of the purse-like root of *Laminaria bulbosa*, especially on and about the rootlets projecting from the part next the rock on which it grows—the only position, perhaps, except by mere chance, in which it could be landed intact—and after this, obtained an abundant supply from these roots, all in a *living* state, but, of course, much washed by having undergone the exposure to which I have alluded.

By the different aids which those accustomed to the examination of microscopic objects are in the habit of applying, I have been able to analyze this little organism, so as to obtain the facts given in the above description.

Examined in the wet way while living, or preserved in spirit and water, by crushing and sectioning, examined in the dried state, and with parts mounted in balsam, all these facts may respectively be obtained; but here, as in every thing else, patience, endurance, and perseverance are necessary to success, bearing always in mind that every specimen when examined, in part or entire, will probably afford something new, and that therefore he who examines most will, *cæteris paribus*, be able to describe the object most correctly.

Although I have often sought for the pseudopodial prolongations of the sarcode from the aperture of *Squamulina scopula* when in sea-water and in a living state and apparently under favourable circumstances as regards rest &c., yet I have never been able to see them. But it should be remembered that they could only be viewed as opaque objects by reflected light, with, at the nearest, only $\frac{1}{2}$-inch compound power, while in general these prolongations can only be just seen by transmitted light with $\frac{1}{4}$-inch, and then only under the most favourable circumstances as regards fresh sea-water, undiminished vitality, and with little or no molestation—a coincidence of conditions so difficult to obtain that I could hardly expect, with the power first mentioned, to be successful.

What, however, I could not obtain in this way while the animal was entire, I have managed to get by dissection while fresh; and thus all but seeing the animal substance *move* has been revealed by the processes just mentioned, under which the necessary magnifying-power with transmitted light could be used with impunity.

By tearing the test to pieces, its composition can be easily ascertained; and, first, we find that it is for the most part composed of colourless hyaline grains of quartz and sponge-spicules, sometimes one preponderating, sometimes the other, the former being so small that they look like pounded glass, and, being *all* colourless, give the test its white appearance; while the latter, which may be entire or fragmentary to an equal degree of minuteness, are derived indiscriminately from all kinds of sponges of the locality, calcareous as well as siliceous. They are chiefly fragmentary about the lower extremity, where they are tessellately connected by chitinous substance exactly like the arenaceous particles on the tests of some *Difflugiæ*, and equally heterogeneous, although, like many *Difflugiæ*, there is evidently a preference here for particular objects, and especially for transparent substances *without* colour, inasmuch as, although nearly every thing else of the kind in the locality (that is, having recourse to foreign objects for the construction of its habitation) partakes of the ferruginous red material (argil and quartz) that, from the contact of the waves with the cliffs of the New Red Sandstone series here, deeply and continually tinges the sea, the animal of *Squamulina scopula* rejects all but the absolutely *colourless* grains: hence it is always pure white.

Further up the column the fragments of the spicules are longer and more projecting, until we arrive at the head, which is one mass of *entire* sponge-spicules of all kinds, arranged very much like pins in a pincushion, viz. with the obtuse or capitate ends, as the case may be, always *outwards*, those only being pointed which are pointed at both ends, *ex. gr.* the spicules of *Halichondria panicea*, Johnston, which, either from its being the most plentiful sponge in the locality, or from preference of the *Squamulina*, or both, so far exceed the rest in number, that the animal may be inferred to prefer points to obtuse ends, when it can get them, for its spiculiferous head.

Not content with grains of quartz and sponge-spicules, we frequently observe other objects, such as chitinous tentacles or setæ of sea-animals, and even filaments of *Melosira*, incorporated with the rest of this heterogeneous assemblage. In short, the animal appears to clothe itself with every thing of this kind that comes in its way, only confining the *entire* spicules chiefly to the head or free extremity, where one of their purposes is evidently to act as strainers, catching fragments of soft bodies, living or dead, which impinge upon them by sinking or current-influence, and thus probably entrapping food after the manner of a spider's web, which the pseudopodia then can easily envelope and draw into the body of the *Squamulina*.

Carbonate of lime also enters into the composition of the test; but this is so trifling in quantity that it is impossible to say if the effervescence does not arise from the presence of fragments of calcareous spicules. Even when dilute nitric acid is applied to the thin disk which is left on the dry fucus, after the superstructure may be broken off, the diminution in bulk of the white material appears to be so trifling, although there has been effervescence, that, when dried again, the deficiency cannot be appreciated.

The chitinous substance in which the arenaceous material is fixed is thicker below than it is above, and about the junction of the column with the summit of the pedestal (that is, about the neck) presents a fibrous structure which binds the former to the latter by a material at once so tough and resilient that the erect or columnar portion may, in the living or wet state, be bent down at right angles to the summit of the pedestal in all directions without breaking or losing its natural elasticity, which, on the other hand, when the pressure is withdrawn, brings the column back to its erect position. Moreover this part, in some specimens, is visibly uncovered for a short distance by the arenaceous coat (fig. 4*a*), and, I think, as the latitude of its movements in every instance indicates, is always so just at the line of junction with the pedestal. How far the animal may make use of this latitude of movement in bending the head this way or that by living contractile power, as the occasion may require, I do not pretend to say; but the head is frequently bowed down on one side or the other, as if the movement had been effected by the animal (fig. 2 *a*).

The base of the pedestal, which is the bond of attachment between the *Squamulina* and the fucus or body on which it may be located, and, although not so thick, is also chiefly composed of the same material as the walls of the other parts of the test, presents a radiated structure which, in a morphological point of view, becomes so interesting that I shall postpone it for more particular description and consideration hereafter (figs. 6 & 7).

Meanwhile, the cavity of the test, like the test itself, consists of two portions, viz. that of the pedestal and that of the column. That of the pedestal more or less corresponds with its external shape, presenting a circular hole at the summit (fig. 5 *a*), which makes it continuous with the cavity of the column, but is modified, in the rest of its extent, by a variable number of pseudo-septal divisions of different lengths, five or six of which, but generally five, are more prominent than the rest, radiating inwards from the circumference of the pedestal towards its centre, short of which they stop, to leave a central area, but are continued upwards, so as partially to divide the cavity of the pedestal into five or more circumferential compartments, the septal prolongations between losing themselves upon the dome of the pedestal as they approach the circular aperture at its summit, and thus causing the central area to form a common cavity with the circumferential compartments, while it is in direct continuation with that of the column.

At the point where the cavity of the pedestal joins that of the column, the union of the two is chiefly effected by chitinous substance *only*, to admit of the motion of the column on the pedestal to which I have alluded—a fact which, although thus indicated, is only now and then satisfactorily seen, when for some little distance at this point the outer or arenaceous coat is absent (fig. 4 *a*).

The cavity of the column itself (*i i i*) consists of a chain of two or more chambers linked together by isthmic constrictions corresponding to the dilatations and contractions respectively of the column, which in full growth do not exceed three or four of the former, as my illustration will show (fig. 3), terminating at last at the summit of the column in the centre of the head of spicules, by a constricted canal like those joining the dilatations, and ending ultimately on the surface in a small aperture (*k*). This aperture, however, can very seldom be well seen, owing to the forest of spicules which surround and intercross obliquely over it in the dried state; but occasionally it is perfectly visible; and when not so, it is frequently marked by a brownish bit of sarcode which fills the opening, and, contrasting in colour forcibly with the white mass of spicules surrounding it, enables the position of the aperture to be easily ascertained.

The animal substance (fig. 11, *a*), which is of a pale yellow colour when living, occupies the cavity of the test, and resembles that of the Foraminifera generally, in consisting of granuliferous sarcode more or less charged with oil-globules. It may be divided into three parts, viz. anterior, middle, and posterior—or into pseudopodial, ventral, and ovigerous. The former, which, like that of *Difflugia*, is more attenuated and less granuliferous than the rest, also furnishes the pseudopodial prolongations; the next division is charged with the frustules of Diatomaceæ, especially the disks and filaments of *Melosira*, minute Algæ like *Rivularia* (*Euactis*?), and bits of dark brown matter from the decaying portion of the root of *Laminaria bulbosa*, near which *Squamulina scopula* likes to congregate, the latter causing the ventral sarcode to assume so much the appearance of the sarcode of *Æthalium* that it may be worth while to allude also to this again more particularly hereafter. Last of all comes the posterior division, which is more or less charged with spherical, transparent, nucleated cells (fig. 4*c*), such as are commonly found in both Foraminifera and the testaceous freshwater Rhizopoda, and which I have often and long since figured and described in these organisms respectively in the pages of this periodical. This portion is a little denser than the rest, occupies the posterior or lower part of the cavity of the column and pedestal, and, when dry and contracted, presents a dark brown colour.

When the column is detached from the pedestal in the living state, the ventral and ovigerous sarcode may be easily pressed out of the lower end of the former (fig. 11), and thus examined under a high power, when the facts which I have mentioned may be easily verified.

In form, the test of *Squamulina scopula* differs very much, first, by age and growth, and, secondly, by some parts being more developed in some specimens than in others. Thus, if young, it may be short, the dilatations only amounting to one or two; or if old, to four or five: hence one of the latter has been chosen for the illustration (fig. 3). The pedestal, also, may be more or less atrophied; and its circumference may, instead of a circular, have a more or less undulating margin.

Absolutely circular it seldom is, from the presence of a slight indentation at one part, which seems to correspond to that seen on the circumferential line of nautiloid Foraminifera, with which we shall presently endeavour to identify it.

Then the columnar part may be erect, sloping, or bent down to one side (fig. 2 *a*), or more or less irregular in form ; but all these differences are so slight, that, whether young or old, straight or crooked, deformed or symmetrical, there is no difficulty in recognizing the animal as the same, when once the nature and general form of *Squamulina scopula* has been ascertained. In some cases, too, this may be modified by the injury to which this delicate little organism must be exposed when hurled upon the shore; for the head in some specimens is much larger than in others, owing frequently, although not always, to the extent to which the fragile spicules have been broken off by the waves. Indeed it has often seemed to me wonderful that any of these delicate little objects of the Lamimarian zone should ever reach the shore in safety. Certainly myriads of them must be ground to powder, and thus disappear amidst the sand and pebbles with which they are tossed about in the land-wash, long before any of them are thrown up beyond the reach of the sea. Yet, but for heavy gales of wind, combined with head-growth and frequent decay of the roots of the fuci, we should never know what much of this zone contains in the way of either animal or vegetative life, since the dredge cannot be used among the rocks, and the constant waving to and fro of the fronds of the fuci, even in an almost motionless sea, defies all attempts to recognize any thing minute much below the surface, and renders every effort to obtain it direct from this zone almost useless.

Food.—I have stated that the spicular head might strain the water passing through it, and thus collect much soft material of a nutritive nature, either living or dead, so that the animal would only have to extend its pseudopodia up the spicules to seize and draw it into its body. But, in addition to this, there is hardly an instance in which remnants of Diatomaceæ are not present in the interior, consisting (for the most part certainly, as before stated) of the disks and filaments of *Melosira*, together with portions of the decaying fucus, thus indicating a power of obtaining food beyond that which may be provided by the straining arrangement of the spicules. Indeed, prior to the formation of the head of spicules at all must be the formation of the pedestal and lower part of the column, which distinctly points out that the animal, from the very commencement, has the means of catching those particles which, floating by it, are found best subservient to the purpose of nutrition and for the formation of its test respectively.

Returning, now, to the pseudo-septal division of the pedestal, let us consider for a moment this structure with reference to its comparative morphology.

When the specimens of *Squamulina scopula* are dried, they are very prone to fall off from their attachment to the fucus; and then they invariably leave the bottom or disk of the pedestal adherent to the former—which at once enables us to see the disk on the fucus (figs. 6 & 7), and the vault of the convex pedestal still connected with the broken-off column (fig. 8 *a*).

If we first look at the disk adhering to the fucus (figs. 6 & 7), we shall observe that it is more or less white, being composed of the same material as the test, and presenting a more or less uneven ring, from which several processes of unequal length radiate inwards. Five or six, but generally five, of these, as before stated, are much more developed than the rest; constricted towards the circumference and inflated towards the centre of the disk, which they do not reach, but leave, as also before stated, a central area, which forms, with the interspaces between the radii, a single common chamber, continuous, through the aperture of the summit of the pedestal (fig. 5 *a*), with the general cavity of the column. The interspaces of the disk are more chitinous perhaps than arenaceous; that is to say, the test is not near so thick here as in other parts.

Turning to the corresponding portion of the pedestal still attached to the column (figs. 8 & 9), we observe that these radiated portions of the disk belong to as many pseudo-septal divisions which, extending upwards, at last lose themselves upon the dome of the pedestal, near the margin of its aperture, and that, in the dried state, a contracted mass of dark brown sarcode (*a*) at this point presents, in its still lobed form (fig. 9 *a*), the indication of its once (when living) having occupied the interspaces between the septal divisions of the pedestal.

Now this radiated disk undoubtedly has very much the appearance of the radiated septa of a coral-polype; but it has a still nearer affinity to the septal divisions of a nautiloid foraminiferous test; and when we compare the whole structure of the pedestal with the latter, we cannot help seeing that the septal divisions are homologous with the septa of a nautiloid foraminiferous test, and that the central area corresponds with the initial or primary cell of a nautiloid individual, which, on being prolonged upwards, in *Squamulina scopula*, developes a column at the expense of the spire.

Following up this view, I by chance found a pedestal *alone*, which I have mounted in balsam and drawn as one of the illustrations (fig. 10), showing so plainly and so unmistakably the remains of the nautiloid chambered spire with an opening in the position of the initial or primary cell, that no doubt can now be entertained of the foregoing conclusions.

I am not quite certain whether this disk, which had fallen off a portion of fucus bearing a number of both species of *Squamulina* (viz. *scopula* and *varians*), preserved in spirit, belongs to the former or to the latter species; for the former *always* has a hole in the summit of its pedestal, and the latter may or may not have it there, as will be seen presently, when it is described; but whether it belongs to one or the other, the observations on the comparative morphology apply equally to both species; and thus the specimen is as conclusive of the homology of *Squamulina scopula* with the nautiloid forms of Foraminifera as it will be found conclusive of the same fact in the description of *Squamulina varians*, the latter being, as it were, merely the pedestal of the former increased in size and somewhat altered in shape by the absence of the columnar portion.

Thus, however much in the first instance we find the radii in the disk of the pedestal of *Squamulina scopula* like the septal divisions of a coral-polype, we shall presently see, in *S. varians*, that where they are altogether absent they leave a simple globular chamber, and that where, on the contrary, they are more or less developed they only present a step further towards the pedestal of *Squamulina scopula*, which is but a transitional form to a nautiloid foraminifer, and not to a coral-polype; that is to say, that the simplest form of *Squamulina* passes thus into a nautiloid form of Foraminifera, and not direct into that of a coral-polype.

Lastly, I alluded to the presence of the dark-brown bits of decaying fucus in the ventral portion of the animal of *Squamulina scopula* as resembling similar contents in the body of an *Æthalium*. I do not mean to identify *Æthalium* in its massive amœboid state (that is, before it comes to maturity, dries up, and developes its sporidia) with a foraminiferous animal; but I mean to say that bits of brown decaying wood and resinous matter may be seen in an *Æthalium*, evidently incepted from the woody tissue in or among which it had been living, much the same as we see the bits of decaying fucus in the ventral portion of *Squamulina scopula*—and, further, that the reproductive cells of *S. scopula* and the Foraminifera that I have examined in a living state are very like the reproductive cells of *Æthalium*, in form and in crowded number, just before the latter pass into the matured or dried state, and become black or otherwise deeply coloured.

Further, also, it might here be added that, whenever specimens of *Leucosolenia botryoides* are wanted, the most likely place to find them will be about the decaying parts of the roots of *Laminaria digitata* and *L. bulbosa*—that *Grantia clathrus*, Schmidt, seeks the same habitat, and that in one specimen (which I possess) the latter has, for some inches in diameter, so densely netted itself over the vault and throughout the branches of the root-bunch of a large specimen of *L. digitata*, that, at first sight, I was doubtful whether I had not one of the Myxogastres before me; so intimately allied in aspect, form, and habitat (the former being, of course, marine, and the latter terrestrial) do these sponges appear to be to this family of Fungi.

Finally, I might add that, in two living specimens of a sponge obtained from different localities, and bearing spicules like those of *Halichondria panicea*, John., but possessing a faint purple tint, I found the purple colour to be produced by its being densely charged with smooth spherical cells so like the sporidia of the Myxogastres, that, but for the presence of the spicules and the specimens being fresh and living, I should have concluded that these cells came from one of the Myxogastres, and did not originally belong to the sponge.

At present it seems to me, from the above observations, that if we are to propose any class-arrangements between the Sponges and the Corals, the Foraminifera must take an intermediate position as the transitional form, unless they be all viewed as branches from a common palæogenetic stock.

Besides *Halyphysema Tumanowiczii* (now our *Squamulina scopula*), Dr. Bowerbank adds another species, to which he has applied the specific designation of "*ramulosa*," and which he states does "not exceed two lines in height and about the same in breadth, and in this space there are eight branches" (Brit. Spong. vol. ii. p. 79). The specimen appears to be unique; and, in the absence of illustration and description of the manner in which the branches come off, this species, although in other respects almost the same as *Squamulina scopula*, must remain in abeyance, until chance favours some one with another specimen, who will give an illustration and a more detailed account of it.

Under the genus *Polytrema*, Dr. Carpenter (*op. cit.* p. 236) alludes to an arborescent specimen which was "completely covered over with a membranaceous sponge, the spicules of which seemed to radiate from the extremities of the branches," and then adds, "Of the parasitic character of the sponge I entertain no doubt whatever."

Can there be any connexion between this and Dr. Bowerbank's branched species of his *Halyphysema*?

Squamulina varians, mihi. Pl. V. figs. 1–5.

Test white, more or less circular, plano-convex, raised or depressed, or conical vertically or horizontally—in short, presenting all kinds of forms from a symmetrical dome-shaped body with circular base to an amorphous mass fringed out, amœba-like, at the circumference into every variety of indentation; possessing a single circular aperture at the base or summit, or anywhere between the two, widening outwards; sometimes crescentic and lateral, at others produced in a circular form on a short neck; composed of colourless grains of quartz and sponge-spicules, fixed or tessellated more or less smoothly in a chitinous substance, which, extending across the base, fixes the test to the surface of the fucus or object on which the animal may be located; evidencing, by effervescence with acid, a slight admixture of calcareous matter, and sometimes, when the fragments of the spicules are long and pointed, or capitate, allowing these to project more or less beyond the surface, the capitate ones with their obtuse ends *outwards*. Base or discoidal portion outwardly extending beyond the body of the test, and terminating in a thin edge, which may be circular, subcircular, or more or less indented; and internally (that is, in the chamber of the test) presenting, at its point of union with the body, a circular, subcircular, or wavy outline, more or less dentated by pointed prolongations of the test inwards, which, after being continued up the side for a little way, cease to appear above the surface of the interior long before arriving at the summit of the dome. Chamber lined by chitinous substance, which chiefly composes the base or disk and thus forms the bond of attachment between the test and the fucus or body on which it may be located. Animal substance occupying the chamber, and consisting of granuliferous sarcode, of a light yellow colour while living, charged with oil-globules, frustules and filaments of Diatomaceæ, chiefly of *Melosira*, and reproductive cells. Size very variable, seldom more (and frequently less) than 1-30th inch in diameter.

Hab. Sea: Laminarian zone, on *Phyllophora rubens* and the purse-like inflation of the root of *Laminaria bulbosa*, in company with *Lagotia viridis*, Wright, chiefly inside, and with *Squamulina scopula*, *Leucosolenia botryoides*, and *Grantia ciliata*, chiefly outside.

Loc. Beach at Budleigh-Salterton.

Obs. This species appears to be so like Schultze's *Squamulina lævis*, that, but for the test being composed of grains of quartz and fragments of sponge-spicules, instead of calcareous matter, I should have said it was one and the same. The arenaceous character of the test, however, makes the difference, if not also its pseudo-septal prolongations into the interior of the chamber. Schultze's calcareous form, which also appears to be much more minute, I have not seen.

S. varians closely resembles in every way the plano-convex portion or pedestal of the foregoing species; we have only to take away the columnar portion of *S. scopula* to have the more simple form of it which appears in *S. varians* when the aperture is in the summit, and the base internally denticulated.

Like the plano-convex portion of *S. scopula*, also, it varies much in its circumferential outline, as it does in the amount and extent of its pseudo-septal radiate prolongations internally, being sometimes without any of the latter, and thus presenting a simple single chamber (fig. 1); while at others it is more or less crenulated throughout by the inward denticulations of the test, approaching the many-chambered form of the nautiloid Foraminifera (fig. 4).

It also varies very much in shape and size (compare fig. 1 with fig. 5), but is always characterized by snow-whiteness, from the minutely comminuted state of the colourless grains of quartz of which the test is composed—thus resembling in this respect, like *S. scopula*, the whiteness of powdered glass.

Sometimes pointed and capitate portions respectively of pin-like spicules are observed to be present, and to project some distance beyond the surface of the test (fig. 1), still further allying it in this respect to *S. scopula*.

There do not appear to be any pores about the surface, and only one large aperture, which varies in position, as above stated, being most conspicuous when on the summit or side of the test.

Occasionally light yellow spots are seen on the test; but this is where the chitinous substance is devoid of the arenaceous material.

The internal contents are also above noticed. It seems to feed mostly on *Melosira*, as there is hardly a specimen which does not contain the disks, both singly and in filament, of this Diatomacean.

Besides, occasionally I found a number of granulated plastic cells, which appeared to me to be a stage in advance towards development of the spherical nucleated reproductive ones (otherwise absent), which might thus be born in the state of *Amœbæ*. Analogy favours this view.

As with *S. scopula*, one cannot help seeing, in the smooth tessellated test, composed especially of quartz-grains &c., a resemblance to the tests of *Difflugia*—and in the selection of those grains only which are colourless, that character where the *Difflugia* chooses one particular object only for the construction of its covering.

The test of this species is even more simple than that of *S. scopula*; for among its varieties is the symmetrical hollow dome with a single aperture, passing gradually into that form with more or less crenulated interior which simulates the nautiloid one of Foraminifera (to say nothing of the variety of external forms)—at the same time that this early signification might associate it, in a morphological point of view, with the radiated septal divisions of the coral-polypes.

I have not been able to see its pseudopodia, for the same reason as stated above for not having been able to see them in *S. scopula*. Nor have I ever been able to prove that it is or is not locomotive. It certainly adheres firmly to the fucus or object on which it may be located, but, when fresh, comes off entire by slipping a sharp knife under it, although, in the dried state, as with *S. scopula*, the body, when broken off, generally (if not always) leaves its disk on the fucus. Schultze's calcareous ones were locomotive, and thus, by being much smaller and creeping up upon the sides of the glass vessel in which they were kept, no doubt enabled him to see, by transmitted light, their pseudopodia. I could have done the same probably with *S. scopula* and *S. varians*, respectively, if I could have applied a high magnifying-power to them, with transmitted light, in their living state.

What vast numbers of free sponge-spicules of all kinds, fragmentary and entire, there must be floating about at the bottom of the sea, in the Laminarian zone, for these little Foraminifera, both *S. scopula* and *S. varians*, to avail themselves of them so plentifully and so indiscriminately for the construction of their habitations!

Difflugia.

Having had by me for a year past the description and figure of a new species of freshwater *Difflugia*, it seems not inappropriate that I should take this opportunity of communicating it; and, from its shape laterally not being unlike that of a plucked goose or other bird of that kind without wings (fanciful as this comparison may be), it may also not be inappropriate to designate it by the following appellation.

Difflugia bipes, mihi. Pl. V. figs. 6–9.

Test oblong, somewhat compressed, expanded posteriorly, narrowed anteriorly (fig. 7); lateral view lageniform, with the body somewhat inflated (fig. 8); posterior extremity obtuse, convex, accompanied on each side by a cruriform conical extension of the test; anterior extremity narrow, terminating in a contracted oral orifice bordered by pointed scales, which, in a circular form, slightly overlapping each other, cover the whole of the test in great uniformity.

Animal composed of colourless granular sarcode, emitted anteriorly in obtuse pseudopodial prolongations (*c*) for progression and the capture of food; ventral portion more or less charged with fragments of Algæ and oil-globules (*g*); posterior extremity containing a large nucleus and nucleolus (*e*), several reproductive (?) cells, and one or more contracting vesicles (*f*, *d*). Body tied by three sarcodal filaments (*h*) to the posterior part of the test and to the extremities of the hollow, conical, leg-like appendages respectively. Molestation causing the body to assume a spherical form, synchronously with which it is suddenly retracted by the sarcodal filaments to the posterior end of the test (fig. 7 *a*). Size about 1-182nd of an inch long by 1-353rd in its broadest part.

Hab. Freshwater pool in heath-bog. Living on minute Algæ (*Oscillaria* &c.). Progressing after the manner of *Difflugiæ* generally, with the test vertical and fundus uppermost.

Loc. Budleigh-Salterton.

Obs. I found three or four specimens of this *Difflugia* about a year since, in the surface-pool of a heath-bog about a mile from this place, viz. on the 29th of January 1869.

There were other *Difflugiæ* present; and I sketched a large one having *oval* and *square* plates upon its test heterogeneously mixed up with grains of sand—showing that the oval and square plates, which frequently and respectively form the coverings of Difflugian tests exclusively, are derived from external sources, and may be taken up by some of the *Difflugiæ* indiscriminately, with grains of sand and other like objects, although they (the oval or the square plates, as the case may be) are frequently selected for the covering of the test, to the exclusion of all other objects, and consequently that the presence of one or the other is of no specific value. (See Dr. Wallich's excellent and elaborate paper, with illustrations, on the Difflugian Rhizopods, Annals, ser. 3. vol. xiii. p. 215 : 1864.)

One cannot help noticing in this mixture an analogy with the arenaceous forms of *Squamulina* just described, which animal, although preferring grains of quartz and sponge-spicules, is not particular in taking up any thing of the kind for the formation of its covering which it may find appropriate.

The light yellow colour of the test of *Difflugia bipes*, together with its obtuse pseudopodia, cause it to differ from *Euglypha*, where the test is colourless and the pseudopodia pointed. Otherwise it much resembles *Euglypha*. Nor does the sudden retraction of the animal by means of the three sarcodal cords attached to the posterior part of its body characterize it as a distinct species less than the peculiar form of the test.

EXPLANATION OF THE PLATES.

Plate IV.

Fig. 1. *Squamulina scopula*, natural size.

Fig. 2. The same, full-grown tests, magnified five times: *a*, inclined position.

Fig. 3. The same, full-grown test, 1-15th of an inch long, greatly magnified, to show structure and cavity: *a*, pedestal; *b b b*, column; *c*, body; *d*, neck; *e*, head; *f f*, brush of spicules; *g*, triradiate spicule of *Grantia ciliata* (calcareous); *h*, trifid spicule of *Pachymatisma* (?); *i i i*, dotted line indicating shape and size of chambered cavity; *k*, aperture; *l l*, tentacular (?) appendages of marine animals.

N.B. This and the seven following figures (viz. 4 to 10, inclusively) are drawn strictly on the scale of 1-24th to 1-1800th of an inch, to show their relative size individually and the relative size of the parts of which they are individually composed; latitude only being given to the spicular detail, wherein the different spicules of the head are intended to represent some of the varieties that may be seen in many, rather than all together in one specimen.

Fig. 4. The same, summit of pedestal, with portion of column truncated close to neck, to show, *a*, circular aperture and chitinous lining.

Fig. 5. The same, upper portion of pedestal with part of column attached, lateral view, to show chitinous lining just about the neck, uncovered by arenaceous coat.

Figs. 6 & 7. The same, disks of the pedestal left on the fucus after the test has been broken off, showing the form of the pseudo-septal divisions prolonged inwards from the margin, but ending short of the centre, so as to leave an open area there.

Fig. 8. The same, pedestal with portion of column attached, broken off from the disk (dried specimen), showing that the pseudo-septal divisions are continued up into the dome: *a a*, portion of animal substance dried, showing, by its lobed form and position, that it occupied the central area and the interspaces between the septal divisions when fresh.

Fig. 9. The same, direct view of the pedestal under the same circumstances, showing the same facts more satisfactorily: *a*, dark portion representing the dried animal substance.

Fig. 10. The same, upper view of the pedestal, showing the chambered form of the interior through the test; test chiefly formed of the fragments of sponge-spicules: *a*, aperture of the summit; *b*, dried animal substance; *c c c*, chambered cavities, lined with chitinous substance.

This specimen, which I have mounted in balsam, indubitably homologizes the "pedestal" with the test of a Nautiloid Foraminiferous animal, together with the development of the "column" from the initial or primary cell.

Fig. 11. The same, lower part of column broken off from the pedestal at the neck while living, and the animal substance forced out by pressure, showing that it is composed of :—*a*, granular sarcode ; *b b*, oil-globules ; *c c c*, reproductive cells about $2\frac{1}{2}$-6000ths of an inch in diameter ; *d*, disk of *Melosira*.

N.B. All the parts of this figure are relatively magnified on a larger scale than the foregoing, viz. on that of 1-24th to 1-6000th of an inch.

Plate V.

Fig. 1. *Squamulina varians*, mihi, greatly magnified, to show the structure and cavity of the test ; elevated convex form, lateral view : *a*, body ; *b*, expanded margin of the disk by which it adheres to the fucus ; *c*, aperture ; *d*, dotted line indicating the form of the chamber ; *e*, projecting ends of spicules. Height of body about 1-69th of an inch, base about 1-54th of an inch in diameter.

N.B. This and the three following figures (viz. 2 to 4 inclusively) are strictly drawn upon the same scale as *S. scopula* (viz. 1-24th to 1-1800th of an inch), to show the relative size of the corresponding parts in each species (*S. varians* corresponding to the pedestal of *S. scopula*) and of their own parts individually, latitude of delineation only being allowed, as in *S. scopula*, to the spicular detail.

Fig. 2. The same, discoidal portion of fig. 1, showing :—*a*, expanded margin ; *b*, dark shade indicating width of wall and attachment of body to disk ; *c*, dark line indicating chitinous lining ; *d*, central or internal portion of disk ; *e*, aperture.

Fig. 3. The same, outline of a disk showing, by the pseudo-septal prolongations, a tendency to trilocular division : *a*, expanded margin ; *b*, central or internal area of disk ; *c c*, pseudo-septal prolongations ; *d*, aperture ; *e*, chitinous lining of chamber.

Fig. 4. The same, outline of a disk showing a tendency to multilocular division : *a*, marginal expansion ; *b*, central or internal area of disk ; *c c c*, pseudo-septal prolongations of the test, causing the basal outline of the chamber to assume a crenulated appearance ; *d*, aperture ; *e*, chitinous lining of chamber ; *f*, disk of *Melosira*, relatively magnified.

Fig. 5. The same, amœboid form of test : *a*, aperture. (Scale 1-48th to 1-1800th of an inch.)

This figure, on half the scale of the foregoing, is to show the extreme variation of form, in this species, which may exist between the simple, symmetrical, dome-shaped figure 1 and the amœboid form, figure 5.

Fig. 6. *Difflugia bipes*, mihi, outline of test, with animal in the interior, greatly magnified : *a*, test ; *b*, animal ; *c*, pseudopodia ; *d d*, contracting vesicles ; *e*, nucleus ; *f*, oil-globules and other reproductive (?) cells ; *g*, fragments of incepted food (Algæ) ; *h*, sarcodal retractile filaments. (Scale 1-24th to 1-6000th of an inch.)

Fig. 7. The same, test empty, showing uniformity of arrangement in the scaly covering ; also, *a*, circular line indicating form and position of animal when suddenly retracted. Greatest length of test 33-6000ths of an inch, greatest width 17-6000ths.

Fig. 8. The same, test empty, lateral view : *a*, imaginary position of pseudopodia.

Fig. 9. The same ; scales more magnified, to show their circular form and mode of arrangement on the test.

XXXIV.—*Descriptions of new Species of Birds from the Solomon and Banks's Groups of Islands.* By G. R. Gray.

A collection of birds that had been obtained among the various islands of the Pacific Ocean by Julius Brenchley, Esq., a series of which he has presented to the British Museum, enables me to select several species as new to the Solomon and Banks's groups. The avifauna of the Solomon Islands was ably treated by Mr. Sclater at a meeting of the Zoological Society held on the 11th February 1869; and the paper appeared in the 'Proceedings' for the same year. This collection containing several species hitherto undescribed induces me to give descriptions of them, and thus assist towards completing the ornithological knowledge of these islands.

Accipiter albogularis.

Male. The upper surface plumbeous black tinted with grey; the base of the feathers on the hind head white; the entire surface beneath the body also white, but irrorated with plumbeous on the chest and thighs.

Length 17″ 6‴, wings 10″, bill 1″ 1‴, tarsi 2″ 4‴.

This bird, of which there is only a single specimen, might at first sight be taken for the *Accipiter haplochrous* of New Caledonia; but it is larger and possesses a white throat, which at once distinguishes it from the latter-mentioned species. It was obtained at Hada or Recherche Bay, San-Christoval Island.

Philemon Sclateri.

Female. Above brown, with an olive tinge; rump and tail dull rufous brown, each feather of the latter margined with yellowish olive; wings fuscous black, with the outer margins of quills yellowish olive, especially of the tertials; top and sides of head fuscous black, each feather broadly margined on its sides with yellowish white; throat white, tinged with grey, with a broad line of black on each side, proceeding from the ears; breast white, with black dashes down the middle of each feather, the black fading into brown on the upper part of the abdomen. Bill yellowish white; feet plumbeous.

Length 11″, wings 5″ 6‴, bill 1″ 6‴, tarsi 1″ 4‴.

"Eyes dark brown. Contents of stomach honey."

A single specimen only is in the collection, which was obtained at Wanga, San-Christoval. This bird was recorded by Mr. Sclater, in his list of Solomon-Islands birds, under the name of *Philemon vulturinus* (Homb. & J.). Through the kindness of that gentleman, I am enabled to rectify, by comparison, this error, which was entirely occasioned by the wretched state of the specimen he had under examination.

Ptilonopus solomonensis.

Female, young. Bright golden emerald-green; quills bluish black, with the tips dark shining green; tertials emerald-green, all narrowly margined with yellow; abdomen and under tail-coverts bright king's-yellow.

Length 8″, wings 5″, bill 9‴, tarsi 6‴.

"Eyes yellow. Contents of stomach large seeds and fruits."

The single specimen of this bird was also procured at Wanga, San-Christoval. It is probable that the mature male of this species, when obtained, may prove to possess a showy plumage, as is the case with most of the species.

Carpophaga Brenchleyi.

Front of head greyish white, with the hind head grey; cheeks and throat pale castaneous; upper surface plumbeous black, tinged with grey; tail above, when closed, black, with the outer feathers, when expanded, and beneath all the feathers rufous castaneous; beneath the body of a very dark rufous castaneous, shading into a lighter colour on the lower abdomen and under tail-coverts.

Length 16″, wings 8″ 9‴, bill 1″ 2‴, tarsi 1″.

"Eyes yellow. Contents of stomach large seeds and fruits. Male."

This fine bird, of which there is only a single specimen, was collected at Wanga, San-Christoval, where it feeds on various kinds of seeds, amongst which are those of a species of *Canarium.* The soft pulp that surrounds the hard shell wherein the seed is placed must be the portion that nourishes the bird during the period they can be obtained.

Megapodius Brenchleyi.

Young. Castaneous brown, with transverse narrow bands of yellowish brown on the back and wings; throat and cheeks fulvous white; beneath the body more rufous than on the upper surface, but without any markings.

Length 5″ 6‴.

"Eyes dark hazel."

A single specimen of the young bird, and two eggs (unfortunately in a broken state) were obtained at Gulf Island, where they were discovered in the month of September 1865. These eggs are, both in size and colour, very similar to that of *Megapodius Brazieri*, described by Mr. Sclater in Proc. Zool.

Soc. 1869, p. 528. In 1864, I observed, in the Proc. Zool. Soc. p. 42, that an egg (very similar in every respect to those above referred to) had been brought from San-Christoval Island. As Gulf Island lies close to this last-mentioned island, it is therefore very probable that the birds of these two islands may eventually prove to be of one and the same species.

I have named these two species after Julius Brenchley, Esq., as a small acknowledgment for the opportunity he has given me of describing the new species contained in his highly interesting collection.

Mr. Sclater, in his paper (Proc. Zool. Soc. 1869) previously referred to, has given (p. 124) a list of the species then known to inhabit the Solomon Islands; to which list I have also the means of adding, through this collection, the following additional species:—

Cuncuma leucogaster. St.-Isabel and Cocatoo Islands.
"Eyes brown. Contents of stomach pigeon." Young.

Haliastur leucosternon. Ugi or Gulf Island.
"Eyes dark brown. Contents of stomach Crustacea."

Collocalia hypoleuca. Ugi or Gulf Island.
"Eyes black. Contents of stomach *very* small insects."

Halcyon albicilla. San-Christoval Island.
"Eyes black. Contents of stomach small Crustacea. Male."

Electus Linnæi. St.-Isabel Island.
"Eyes red. Contents of stomach small fig-seeds."

Electus intermedius. St.-Isabel Island.
"Eyes dark brown. Young female."

Mr. Sclater seems to have overlooked his species *Cacatua ophthalmica*, which he has stated is from this group of islands.

This collection also contains four species of birds that had been obtained at Vanua Levu, which forms one of the islands of Banks's group. I am thus able to record two new species and two other previously known species as inhabitants of this group of islands.

Lalage Banksiana.

Top of the head, back, part of wings, and a transverse pectoral band black; lore, eyebrows, sides of head, and throat pure white; beneath the body, part of great wing-coverts, tertials, rump, and tail buffy white; the latter has the middle feathers mostly, and outer margins of the others more or less black.

Length 6″, wings 3″ 3‴, bill 10‴, tarsi 10‴.

"Eyes black. Contents of stomach insects. Male and young male."

Rhipidura spilodera.

Fuscous black; eyebrows white; throat and breast white, each feather marked in the middle with black; abdomen pale fulvous white; quills dark fuscous black; tail fuscous black, with the tips and inner margins white.

Length 7″, wings 3″, bill 7‴, tarsi 12‴.

"Eyes black. Contents of stomach insects. Female."

This bird, of which there is only one example, is like *Rhipidura pectoralis*, Homb. & Jacq., of the island of Vanikoro; but the spots on the breast extend up to the mentum.

With the two preceding species the following were also obtained:—

Myiagra melanura.

"Eyes dark brown. Contents of stomach insects. Young male."

Trichoglossus Massenæ.

"Eyes red. Contents of stomach honey. Young male."

Mr. Sclater has recorded that an egg of a Megapode which he has described, under the name of *Megapodius Brazieri*, in the Proc. Zool. Soc. 1869, p. 528, had been found and brought from the Banks's group. Mr. Brenchley's collection contains three specimens of eggs of a Megapode that were obtained at Vanua Levu, two of which are similar in colour and size to that described by Mr. Sclater; but the third example is a dirty white. Mr. Brenchley has a note in reference to them, that they were found in the vicinity of the hot springs on the mountains during the month of August 1865.

The neighbouring group of islands, the New Hebrides, is also the abode of a species of Megapode; and we are told by Capt. M'Leod that they are found abundantly, especially on Tanna and Sandwich Islands. Both these islands are also referred to by Mr. Brenchley, who remarks that on the first-mentioned island a large bird is spoken of as living in the vicinity of the Vulcanos; while in the second island eggs of a Megapode had been offered for sale.

It may be remarked that the mature state of the bird of both these groups of islands is at present unknown to ornithologists.

Another new species from the New-Hebrides group is also worthy of being added to these descriptions, as it is also contained in the same collection:—

Glyciphila flavotincta.

It is very like *Glyciphila modesta*, G. R. G., of New Caledonia; but it is rather larger in all its proportions, and it has a prominent tinge of yellow on the back and beneath the body, which is not found on the bird referred to.

Length 6″, wings 3″ 3‴, bill 12‴, tarsi 10‴.

"Eyes black. Contents of stomach honey. Male and female."

Three specimens were obtained at Erromango Island.

XXXV.—*On Fertilization in Ferns.* By Dr. Edward Strasburger*.

The author affirms that he is enabled, by a series of observations on the prothallia of *Pteris serrulata* and *Ceratopteris thalictroides*, to correct certain errors of previous observers as to the way in which fertilization is effected in Cryptogams, and considers that the results attained by him in these instances are calculated to throw a new light on the whole subject. He commences the account of his experiments by tracing the development of the antheridia, or cells producing the spermatozoids, from their earliest condition, and states that the growth of their lateral cells presents the first example of annular-cell formation by division in the vegetable kingdom—a fact brought to notice by Dr. L. Kny in a paper communicated to the Society of the Friends of Natural History in Berlin, in November 1868†. After detailing step by step the growth of the cells in an antheridium, Dr. Strasburger observes that the new twin cells, viz. the central cell and the annular lateral cells, are distinguished from ordinary cells by the difference of their contents, the inner one being stuffed with granular protoplasm, the outer ones containing, at first, an almost colourless sap, with a single, scarcely discernible nucleus, and a few scattered grains of chlorophyll. He then describes the formation of the cells producing the spermatozoids in the following manner:—

Pteris serrulata presents several forms of antheridia: in young prothallia they are commonly unicellular, in older ones

* From Pringsheim's 'Jahrbücher für wissenschaftliche Botanik,' vii. Band, 3tes Heft. Communicated by C. E. Broome, F.L.S. &c.

† "Ueber den Bau und die Entwicklung des Farrn-Antheridiums." Berlin, 1869. (Ann. Nat. Hist. p. 233 of the present volume.)

frequently many-celled. In unicellular antheridia the whole space becomes the mother cell of the spermatozoids; in those consisting of many cells the central cell alone becomes the mother cell. By a series of partitions the mother cell is divided into numerous small cells, which are the special mother cells of the spermatozoids; each of these possesses a distinct nucleus; by mutual pressure they become at first polygonal; their arrangement then becomes confused, the nucleus disappears, giving place to a uniformly granular mass. A rose-coloured vacuole soon appears in this mass, the protoplasm gradually retreats towards the walls of its cell, the central vacuole becoming proportionally enlarged; small granules next appear suspended in the fluid contents, the protoplasm collected against the cell-walls divides itself into a spiral band, which, commencing from a single point, describes several coils around the central vacuole. During this process the special mother cells assume more and more a globose form, and separate themselves from each other, their walls gradually becoming more delicate. The lateral cells meanwhile are compressed by the increasing volume of the contents of the central ones, and the upper or crown cell is filled by the special mother cells. If the antheridium be now placed in water, the top cell is ruptured in a stellate manner by the expansive force of the contents, and the special mother cells make their escape through the opening. The annular lateral cells of the compound antheridia now become of use; for, as the special mother cells make their exit, the former increase in bulk, and force the remaining special mother cells out of the central cell. The spermatozoid commonly lies quiet for so long a time as the special mother cells require for opening; its coils are closely pressed one on another within the cell, and must exercise a certain elastic force on its walls. The softened membrane at last gives way, the spiral coil suddenly unfolds itself, and the spermatozoid moves rapidly away. The special mother cell now disappears. During its motion the spermatozoid turns rapidly on its axis; its body forms three or four coils, which become wider as they recede. The foremost narrow coils are beset with long cilia: on the last and widest coil a colourless vesicle is visible, containing numerous minute granules; this seems to be the vacuole before noticed in the contents of the special mother cell. The vesicle is adhesive; and the spermatozoid may be sometimes seen hanging on by it to foreign bodies, where it struggles to free itself, in failure of which, the hinder end of the spermatozoid produces itself into a long thread, which is eventually torn asunder. The vesicle swells out in water; and if the spermatozoid cannot get quit of it, it becomes so large as to hamper its movements and prevent its advancing; such spermatozoids may be seen, when the period of their swarming is nearly over, sinking to the bottom, where the vesicle and finally the spermatozoid are absorbed.

Before proceeding to relate the behaviour of the spermatozoids, Dr. Strasburger thus describes the development of the archegonia:—

Certain cells on the underside of an old prothallium, just behind the indentation of the front margin, and where it has attained some thickness, become the mother cells of archegonia. One of these cells is first divided, in a direction parallel to the surface of the prothallium, into an inner and larger cell, which becomes the central cell of the archegonium, and an outer, rather smaller one, which, after repeated division, forms the neck of the archegonium; by subsequent divisions the mother cell acquires two or more layers of cells. The canal through the neck is formed by the retreat of its central layer of cells from their contact with each other, or by absorption, where a central layer exists. But previously to this a delicate spherical cell is formed around the nucleus of the central cell, which becomes the mother cell of the future plant. A mass of protoplasm is then collected around the nucleus of the central cell, the protoplasm is separated from the other contents of the central cell by a convex line of demarcation, and thus becomes an independent cell; but no membrane composed of cellulose is demonstrable. The cell formed within the central cell is not the germ-vesicle, but rather the canal-cell, as Pringsheim has shown in *Salvinia.* The remaining contents of the central cell constitute the future germ-sphere; in its midst, close beneath the canal-cell, there lies a large nucleus with a distinct nucleolus. After further divisions of the neck-cells, the canal-cell pushes itself between them, and carries them up with it; within this cell a number of nuclei may now be seen. The growth of the cells of the neck does not proceed equally on all sides, so that the neck is bent down, and its crown cell turned towards the prothallium. When the number of the neck-cells is complete, another series of divisions takes place in the cells surrounding the central cell; at the same time the nuclei of the canal-cells resolve themselves slowly into a number of little granules, and unite at length into a granular mass, which soon fills the whole canal. The lower neck-cells now enlarge, thereby diminishing that portion of the canal; and its granular contents are thus partially forced into the upper part, there forming a wedge-shaped mass, which connects itself by a frequently very slender thread with that occupying the central cell. If the archegonium be now brought into contact with water, the contents of the canal swell visibly, and a number of vacuoles appear in the internal granular mass. The distention increases; and at the apex, where the wedge-shaped mass was collected, the pressure becomes considerable: the free space in the canal is thus enlarged, and at last the upper cells of the neck can no longer resist; they part at the angles of contact, and the mucus is ejected with considerable force. The opening of the canal of the neck occurs at two periods: at first the mucus, which is massed at the summit, is poured out, either at once or at short intervals; then a period of rest occurs, after which the mass collected in the central cell is ejected altogether. The mucus is voided with sufficient force to remove any foreign bodies that may lie before the mouth of the canal, and thus to clear its orifice. The granular inner mucus is thus deposited at some little distance from the mouth of the archegonium; the outer, highly refractive mucus, on the other hand, which lined the walls of the canal, diffuses itself in the water in lines radiating from its mouth. After this evacuation the naked germ-sphere remains in the central cell; it assumes a globose form; and a transparent spot may, under favourable circumstances, be seen at its summit just above the nucleus, which may be denominated the germ-spot. The germ-sphere is now ready for fertilization.

Dr. Strasburger has been able to follow this process in all its details. In *Pteris* the opening of the canal and the entrance of the spermatozoids can be readily seen; but *Ceratopteris* exhibits in the clearest manner the proceedings of these bodies within the central cell, owing to the transparency of its prothallium. After the canal was opened, the spermatozoids, which had previously passed by it with the same indifference that they exhibited towards other bodies, showed a remarkable behaviour. When they reached the mucus before the canal, their movements became slower; they were evidently detained there, and their motion stopped, by an opposing medium: several remained fast in the mucus; others succeeded in freeing ing themselves and hastened away. But generally the course of the spermatozoid was so directed by the mucus radiating from the mouth of the canal that it steered head foremost for that aperture. One is not to imagine, however, that there was any diffusing stream or whirlpool, seizing on the spermatozoid and drawing it towards the orifice; for small granules remained perfectly quiescent in that position. The movement of the spermatozoid within the mucus then became slower; it did not cease to revolve on its axis, but the mucus directed it to the canal; so that its operation there may be compared to the action of the stigmatic juice, or of the tela conductrix which directs the pollen-tube in Phanerogams towards the germ-vesicle.

We have here a proof of the fallacy of Roze's notion that it is the caudal bladder of the spermatozoid which contains the fertilizing matter. The greater number of these bodies had already lost this appendage before they reached the archegonium; others, which retained it at that time, lost it in the mucus; but no one carried it with it into the archegonial cell. In *Ceratopteris*, on one occasion, six spermatozoids, which had just escaped from their antheridium, had entered into the central cell of the archegonium, after which their six bladders were visible in the mucus before the mouth of the canal. Having entered the canal, the coils of the spermatozoid separated themselves from each other; and if no impediment arose in its course, the spermatozoid soon arrived in the central cell. Here the coils were again drawn together, and its movements again became free. The first spermatozoid was soon followed by others: four or five were able to find room in the cell; they there moved rapidly about amongst each other; later arrivals remained fast in the canal. In *Pteris* the number was sometimes considerable; each new comer twisted itself in between those already arrived, so long as any movement was possible; at last it extended itself at full length. When the canal was already full, one of these bodies was seen to insert its foremost end between those previously arrived, and so on, till a long chain of them was formed extending outwards from the canal-mouth. In this chain a spermatozoid might be seen revolving on its axis; and sometimes one would free itself and hasten away; Dr. Strasburger has observed one hundred of these bodies in a single chain in *Pteris serrulata*; others might be seen still involved in the mucus half an hour after the first had reached the central cell.

From the facts above stated, Dr. Strasburger considers it undeniable that it is the mucus which acts upon the spermatozoids; and his opinion was confirmed by removing this substance from the mouth of the canal, by raising the covering glass or with a needle, when the spermatozoid either remained in the mucus, and perished there, or, if it succeeded in freeing itself, it never more found its way back to the canal-mouth. The first spermatozoid that gained the central cell, either at once, or after wandering about a short time, impinged with its foremost end on the transparent or germ-spot on the summit of the germ-sphere, and there remained fast; it then turned quickly on its axis, and sank with its point slowly into the germ-sphere; its movements became slower; they soon ceased entirely; it continued to pass out of sight within the germ-sphere, and dissolved away in its mass till, at the expiration of three or four minutes, no more could be seen of it. This operation was only witnessed five times out of numerous experiments, and when a single spermatozoid alone had penetrated into the central cell, owing to the canal being occupied by adventitious matters. When several spermatozoids had reached the central cell, they moved about amongst each other, so that it was impossible to follow any individual. Sometimes two or three of these bodies remained with their hinder ends attached to the germ-spot; they turned quickly on their axis, pushing one another aside, till one gained the mastery, and was so far received that it covered up the germ-spot with its coils. The others were then repulsed, and moved about for some time, their motions ceasing at times, to be recommenced after short intervals; this may have lasted eight or ten minutes, when they all sank to rest, and remained motionless where they fell. In one case, when two spermatozoids had reached the central cell, the second approached after the first had occupied the germ-spot a minute and a half and its front coils had been received into the germ-sphere; the second could not then displace the other, but soon relinquished its hold on the germ-spot, and, after long roving about, lay on its side near the germ-sphere. After four minutes nothing more was seen of the first; and after thirty-five minutes the second was also lost sight of. The usual results of the fertilization followed in the growth and colouring of the embryo, and were very conspicuous after the lapse of a few days.

Dr. Strasburger concludes his account by observing that fertilization seemed to be effected in these instances by a single spermatozoid, and considers it probable that the procedure is similar in the other Cryptogams which produce these bodies. The chief point of interest in the above experiments (which the author appears to have carried further, and to have detailed with greater accuracy, than previous observers) consists in the means adopted by nature to conduct the spermatozoids to the scene of their operations, and in his reasonings on the nature of their movement, which has been sometimes supposed to be connected with molecular motion by those who have not observed it with sufficient care. It remains for future investigators to ascertain if the same facts can be traced in other Cryptogams.

XXXVI.—*On the British Species of* Didymograpsus. By Henry Alleyne Nicholson, M.D., D.Sc., M.A., F.R.S.E., F.G.S., Lecturer on Natural History in the Extra-Academical School of Edinburgh.

[Plate VII.]

The genus *Didymograpsus* was originally proposed by M'Coy (1851), to include those Graptolites which are "bifid from the base" (Palæozoic Fossils, p. 9). In the year 1852, Geinitz proposed the genus *Cladograpsus*, chiefly for such forms as had been intended by M'Coy to be placed under *Didymograpsus*. With these, however, he placed species which have been subsequently removed by Hall to the genus *Dicranograpsus* (e.g. *D. ramosus*). Still, under the head of *Cladograpsus* Geinitz placed none but such forms as were understood by the *species gemellæ* of Bronn, or, in his own words, "zweiarmige oder gabelförmige Graptolithinen." Recently the genus *Cladograpsus* has been redefined by Mr. Carruthers, and has been made to include two generic forms which not only are in no sense "species gemellæ," but which differ from one another so widely that they cannot be placed under the same genus at all (viz. *Pleurograpsus linearis*, Carr., sp., and *Helicograpsus gracilis*, Hall, sp.). There can be no hesitation, however, in retaining the term *Cladograpsus* simply in the sense in which it was employed by its original inventor—namely, as a synonym for *Didymograpsus*.

The genus *Didymograpsus* was rejected by Hall upon very insufficient evidence, in the belief that all the forms included under this head would be found ultimately to be fragmentary, and to be merely portions of compound Graptolites. Hall, however, has failed to show that this is the case, in America, with any other species than *D. caduceus*, Salt., which he proved satisfactorily to be referable really to *Tetragrapsus bryonoides*, a four-stiped species. No British palæontologist, however, doubts for a moment the integrity of the forms referable to *Didymograpsus*; and, in point of fact, the genus is one of the most natural in the whole family of the Graptolitidæ.

The genus *Didymograpsus* may be defined as comprising those Graptolites in which the frond is bilaterally symmetrical and consists of two monoprionidian branches springing from an "initial point," which is generally marked by a distinct mucro or "radicle." In some cases the radicle may be very rudimentary, as in *D. sextans*, Hall, and in some examples of *D. bifidus*, Hall; and it seems sometimes to be even altogether absent, as in many specimens of *D. anceps*, Nich.

The species of the genus *Didymograpsus* may be conveniently and naturally divided into three sections :—

I. Those *Didymograpsi* in which the radicle is on the inferior aspect of the frond, and the cellules are on the opposite or superior aspect, whilst the "angle of divergence" of the two stipes is not greater than 180°. This group comprises *D. Murchisoni*, *D. geminus*, *D. affinis*, *D. patulus*, and, in fact, the greater number of the *Didymograpsi*.

II. Those *Didymograpsi* in which the radicle is on the inferior side of the frond, and the cellules on the opposite or superior aspect, as before; but the angle of divergence of the stipes is now greater than 180°. In this group, which differs from the last only in the fact that the stipes are reflexed, are *D. flaccidus*, Hall, and *D. anceps*, Nich.

III. Those *Didymograpsi* in which the radicle maintains its position, but the situation of the cellules is reversed, these being now placed on the inferior aspect of the frond, or on the *same* side as the radicle. In this group are *D. sextans*, Hall, and *D. divaricatus*, Hall.

For the full comprehension of the value of the above divisions, it is necessary to define exactly what is to be understood by the "angle of divergence," since this term has been very loosely employed, and has led to a great deal of confusion. As I have before had occasion to remark, it is perfectly obvious that in any *Didymograpsus* the two stipes form *two* angles—one upon one side of the frond, and one upon the opposite side. Each of these angles has, in different species, been treated as the angle of divergence; but it is absolutely necessary to fix accurately one of these angles, which can be constantly employed as a standard of comparison. In the foregoing definitions, therefore, and in the following descriptions, I shall employ the term "angle of divergence" solely for the angle included between the stipes on the side of the frond *opposite to that on which the radicle is situated.* The other angle, or the angle included between the stipes *on the same side as the radicle*, I shall term the "radicular angle." As the radicle in all cases marks the organic base of the frond, we obtain thus a constant standard of comparison between the different species, however much the position of the cellules may vary.

It will, then, be at once seen, that in the first two sections of *Didymograpsus*, the "angle of divergence" is on the *same* side of the frond as the cellules, or, in other words, it is the angle included between the celluliferous margins of the stipes. In *D. sextans* and *D. divaricatus*, however, which constitute the third section of the genus, this state of affairs is reversed—the "angle of divergence" being now on the *opposite* side of the frond to the cellules, whilst it is the "radicular angle" which is included between the celluliferous margins of the stipes.

The genus *Didymograpsus* is characteristically, and, as far as is yet known, exclusively, confined to the Lower Silurian period. Not only is this the case, but the genus is very decidedly more richly represented in the inferior portion of the Lower Silurian series than in its higher portions. The genus attains its maximum in the Skiddaw and Quebec group (Lowest Llandeilo), where it is represented by no less than nine British species and an equal number of American forms, of which, however, some appear to be nothing more than mere varieties. In the Lower Llandeilo or Arenig group we have two very characteristic British species (*D. geminus*, His., and *D. patulus*, Hall), both of which occur also in the Skiddaw Slates. In the Upper Llandeilo rocks we have four British species, with at least one additional American form (*D. serratulus*, Hall), which only occurs in Britain in the Skiddaw Slates. In the Caradoc or Bala series no *Didymograpsi* occur, except in Ireland, where two species are found in rocks of this age (Baily). In the most richly graptolitiferous Caradoc beds which occur throughout Britain, namely the mudstones of the Coniston series of the north of England, no single *Didymograpsus* has hitherto been detected. The same absence of *Didymograpsi* appears to obtain in certain strata in Scotland which overlie the Graptolitic shales of Moffat, and which have been recently described by Mr. Lapworth of Galashiels as the probable equivalent of the Coniston Mudstones, under the name of the Gala beds. In America, however, several species of *Didymograpsus* are known to occur in the Utica Slate and Hudson-River group, two formations which are believed to be of Bala age.

In the last edition of 'Siluria,' Mr. Carruthers mentions ten species of *Didymograpsus* as occurring in Britain; but some of these cannot be retained as valid species. In the following communication I shall describe fourteen species of the genus, with which I am acquainted as occurring in Britain. Several of these, however, have been already described as fully as the extant materials will permit; and of these I shall merely give a short diagnosis accompanied by an illustration, so as to enable them to be readily recognized.

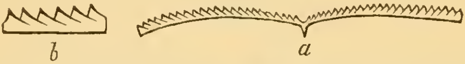
Didymograpsus patulus, Hall, sp. Pl. VII. figs. 1, 1 *a*.

Graptolithus patulus, Hall (Grapt. Quebec Group, p. 71, pl. 1. figs. 10–15).

Didymograpsus hirundo, Salt. (Quart. Journ. Geol. Soc. vol. xix. p. 137, fig. 13 *f*; Mem. Geol. Survey, vol. iii. p. 331 and pl. 11. figs. 6 & 7).
Didymograpsus patulus (Nicholson, Quart. Journ. Geol. Soc. vol. xxiv. p. 135).

Frond composed of two monoprionidian stipes diverging from a small radicle at an angle of 180° (sometimes a little less, and very rarely a little more). The stipes have a very considerable length, reaching two or three inches each without showing any signs of a termination. The stipes are narrow at their commencement, but widen out gradually till a width of one-tenth of an inch may be attained. In smaller specimens, however, as in the subjoined cut, this width is not

Fig. 1.



a, Small specimen of *Didymograpsus patulus*, Hall, from the Skiddaw Slates of Outerside, near Keswick, nat. size; *b*, fragment of *D. extensus*, enlarged, to show the smaller inclination of the cellules.

reached. The cellules are on the opposite side of the frond to the radicle, or, in other words, they occupy the sides of the angle of divergence. The number of cellules to an inch is from thirty to thirty-two or thirty-four in our British specimens, but is stated by Hall as not more than from twenty-four to twenty-six in the American examples. The cellules make with the axis an angle of between 50° and 60°; the cell-mouths make an angle of 100° to 120° with the axis, and they are always produced into well-marked submucronate denticles. In Hall's better-preserved specimens the outline of the cell-apertures is seen to be curved, and the walls of the cellules are marked with fine striæ or lines of growth running parallel to the cell-mouths.

On comparing Hall's beautiful figures of this species with the woodcut in Mr. Salter's above-quoted paper, there cannot be any question that *D. hirundo*, Salt., is the same as *D. patulus*, Hall; and the latter name must be retained, as it has the priority. In the Memoir of the Geological Survey (vol. iii. p. 331), Mr. Salter's description confirms this in every respect. The figures 6 and 7 in pl. 11 of the same work are not named, but they are apparently intended for *D. hirundo*. If this be so, they neither conform with Mr. Salter's own description and previous figure of the species, nor with Hall's account of *D. patulus*. It is probable, therefore, that some error has crept in here, and the figures have not been intended for *D. hirundo*. The *Didymograpsus* figured in Lyell's 'Elements,' at p. 563 (fig. 656), and by some oversight named *D. geminus*, His., is also really *D. patulus*.

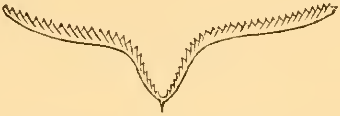
Loc. Skiddaw Slates of Outerside, near Keswick, and Egg-beck, near Pooley; Lower Llandeilo, west of the Stiperstones. (Also in the Lower Graptolite schists of Sweden, and the Quebec group of Canada.)

Didymograpsus V-fractus, Salt.

(Quart. Journ. Geol. Soc. vol. xix. p. 137, fig. 13 *e*.)

This species, of which I subjoin a cut taken from Mr. Salter's figure, was originally named by Mr. Salter from a specimen obtained from the Skiddaw Slates. Mr. Salter, however, never gave any description of the species, so that, unfortunately, it is hardly possible at present to decide positively as to its value. My own collection includes a few fragments, but no perfect specimen. The character upon which the spe-

Fig. 2.



Didymograpsus V-fractus, after Salter. Skiddaw Slates.

cies was founded is the peculiar curvature of the stipes, which are bent abruptly outwards at the distance of about a quarter of an inch from the radicle. The fragments in my possession exhibit this character, but in all other respects they are absolutely undistinguishable from *D. patulus*, Hall. I should therefore be disposed to think that the form cannot be regarded as more than a *variety* of *D. patulus*, unless this character can be shown to be constant in a considerable number of examples.

Loc. Barff, near Keswick (Skiddaw Slates).

Didymograpsus extensus, Hall, sp. Pl. VII. figs. 2, 2 *a*.

Graptolithus extensus, Hall (Grapt. Quebec Group, p. 80, pl. 2. figs. 11–16).

Frond composed of two long slender stipes diverging at an angle of 180° from a small radicle. The stipes attain a length of several inches without showing any signs of a termination. They have a breadth of about one-fiftieth of an inch close to the radicle, and not more than one-fifteenth of an inch at the distance of three inches from the radicle. Cellules twenty-four in the space of an inch, making with the axis an angle of about 45°; the denticles angular and pointed, but not mucronate, the cell-mouths making an angle of about 100° with the axis.

Of this species I have only a single example, which I have recently obtained from the Skiddaw Slates; but its state of preservation is better than that of most of the Graptolites of this formation, and I have no doubt as to its identity with the Quebec form. In most characters *D. extensus* agrees with *D. patulus*, especially in the shape of the frond; the two forms, however, appear to be satisfactorily separated by some minor but constant differences. The stipes are altogether much more slender than in *D. patulus*; the cellules are slightly fewer to the inch, and make a smaller angle with the axis, and they are not prolonged into markedly submucronate points. To show these differences, I have reproduced Hall's enlarged figures of fragments of the two forms (Pl. VII. figs. 1 *a* & 2 *a*).

Loc. Skiddaw Slates, Outerside, near Keswick.

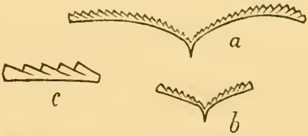
Didymograpsus nitidus, Hall, sp. Fig. 3.

Graptolithus nitidus, Hall (Grapt. Quebec Group, p. 69, pl. 1. figs. 1–9).
Didymograpsus nitidus (Nicholson, Quart. Journ. Geol. Soc. vol. xxiv. p. 135).

Also figured, but not named or described, by Mr. Salter in the Quart. Journ. Geol. Soc. vol. xix. p. 137, fig. 13 *d*.

Frond composed of two simple stipes proceeding from a small pointed radicle at an angle of 150° to 175°. The stipes vary in length from one-half to three-quarters of an inch, and are very narrow at their commencement, but widen out till a width of from one-twentieth to one-fifteenth of an inch may be

Fig. 3.



a, Didymograpsus nitidus, from the Skiddaw Slates, nat. size; *b*, a smaller example, slightly enlarged; *c*, fragment, enlarged, to show the cellules.

attained. The cellules are on the opposite side of the frond to the radicle, or occupy the sides of the angle of divergence. They vary from thirty-two to thirty-four in the space of an inch, and are inclined to the axis at an angle of from 40° to 45°. The denticles are simply angular, and are not submucronate, and the cell-mouths are nearly at right angles to the cell-walls.

This exceedingly pretty little species occurs pretty abundantly and in a state of beautiful preservation in one locality in the Skiddaw Slates. The specimens from which the above description is taken agree perfectly with some of Hall's figures (pl. 1. figs. 1, 6, 9); but Hall has referred to this species other examples (pl. 1. figs. 3, 7, 8) which are considerably larger, and which approximate more closely to *D. patulus*.

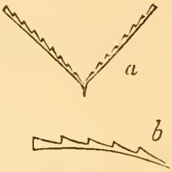
Loc. Skiddaw Slates, Barff, near Keswick.

Didymograpsus affinis, Nich. Fig. 4.

(Ann. & Mag. Nat. Hist. October 1869, pl. 11. fig. 20.)

Frond composed of two simple linear stipes, of extreme tenuity, proceeding from a long pointed radicle at an angle of divergence of from 90° to 150°. The stipes vary in length from one-half to three-quarters of an inch each, and have a uniform width of not more than from one-fortieth to one-fiftieth of an inch, which never appears to be exceeded. The cellules are on the opposite side of the frond to the radicle, or occupy the sides of the angle of divergence. In shape the cellules are altogether undistinguishable from those of *G. Nilssoni*, Barr., and they vary from sixteen to eighteen in the space of an inch. They are inclined to the axis at an extremely low angle (from 15° to 20°); they do not overlap one another at all; and the cell-mouths are from three to four times as short as the outer cell-walls, and form short transverse apertures at right angles to the axis.

Fig. 4.



a, Didymograpsus affinis, from the Skiddaw Slates, nat. size; *b*, fragment of the same, enlarged.

This little species occurs in great numbers, all confusedly matted together, in some parts of the Skiddaw Slates, it being rare to find a detached individual showing both sides of the frond. The characters of the cellules are alone quite sufficient to separate the species from all other known forms.

Loc. Lower beds of the Skiddaw Slates, Barff, near Keswick; upper beds of the Skiddaw Slates, Ellergill, near Milburn, and Eggbeck, near Pooley.

Didymograpsus serratulus, Hall, sp. Pl. VII. figs. 3, 3 *a*, 3 *b*, 3 *c*, 3 *d*.

Graptolithus serratulus, Hall (Pal. N. York, vol. i. p. 274, pl. 74. fig. 5).
Didymograpsus serratulus (Nicholson, Quart. Journ. Geol. Soc. vol. xxiv. p. 136).

Frond composed of two long and very slender stipes proceeding from a long and slender radicle and including between them an angle of divergence which may be stated to average 140°. If I am right, however, in referring to this species a number of ill-preserved forms which occur in the Skiddaw Slates, the angle of divergence is exceedingly variable, ranging from no more than 80° up to very nearly 180°. In the figures which I have given of these Skiddaw-Slate specimens, fig. 3 may be taken as the typical form; and there can be no doubt of the identity of this with Hall's species. Fig. 3 *c* shows a form apparently the same in all essential characters, but having an angle of divergence of close upon 180°, whilst fig. 3 *d* exhibits a very much smaller angle, but is in other respects the same. The preservation, however, of these forms is so bad that it is impossible to be positive as to their absolute identity.

In all these cases we have the following common characters, when the state of preservation is such as to allow of their determination:—

The stipes are exceedingly slender, from one-fortieth to one-thirtieth of an inch at their commencement, and they widen out very slowly, never attaining a greater width than from one twenty-fourth to one-twentieth of an inch. The length of the stipes is very great, being over four inches in one specimen. In the most typical forms the stipes are perfectly straight, but in others they are gently curved. The cellules are always on the opposite side of the frond to the radicle, or occupy the sides of the angle of divergence. They vary in number from twenty-five to more than thirty in the space of an inch; they make a small angle with the axis; and the cell-mouths are at right angles to the axis, giving the fragments a close superficial resemblance to *G. sagittarius*. The radicle is always very long and slender.

The only Skiddaw-Slate species with which these could be confounded is *D. extensus*; but the radicle in this species appears to be always short and blunt, and the stipes attain a decidedly greater width, whilst the angle of divergence is constantly 180°. The preservation of the specimens here referred to *D. serratulus* is too poor to allow of any more minute comparison.

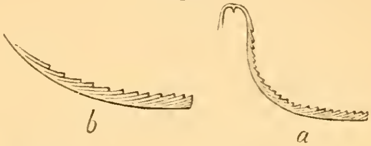
Loc. Skiddaw Slates (lower beds), Outerside and Barff, near Keswick; (upper beds) Thornship Beck, near Shap.

Didymograpsus fasciculatus, Nich. Fig. 5.

(Ann. & Mag. Nat. Hist. October 1869, pl. 11. figs. 21, 22.)

Frond consisting of two simple stipes arising from a short obtuse radicle, at a primary angle of about 330°, but afterwards curved away from the radicle, so as to become nearly horizontal. The angle of divergence of the stipes may therefore be stated upon the whole as 180°. The stipes are extremely narrow at first, but widen out till a width of one-

Fig. 5.



a, Didymograpsus fasciculatus, from the Skiddaw Slates, restored; *b,* a fragment, enlarged. The inclination of the cellules to the axis is too great in these figures.

twenty-fourth of an inch or more may be attained. The cellules are on the opposite side of the frond to the radicle, or occupy the sides of the angle of divergence. They are excessively long and narrow, about twenty-four in the space of an inch, curved in accordance with the curvature of the stipes, overlapping one another for fully two-thirds of their entire length, the cell-mouths being at right angles to the axis. The common canal is extremely narrow.

The materials in my possession for a diagnosis of this species are not satisfactory. Those specimens which exhibit the general form of the frond are too ill-preserved for a proper determination of the cellules; and those which exhibit the cellules are all fragments broken off close to the radicle. I am, however, fully satisfied of the identity of the two sets of specimens, and have therefore ventured to restore the species provisionally, in the hope of shortly obtaining more perfect examples.

Loc. Upper beds of the Skiddaw Slates: Ellergill, near Milburn; Thornship Beck, near Shap; and Eggbeck, near Pooley.

Didymograpsus geminus, His. Fig. 6.

(See Hisinger, Lethæa Suecica, pl. 38. fig. 3; .Salter, Quart. Journ. Geol. Soc. vol. xix. p. 137, fig. 13 *c*, and Mem. Geol. Survey, vol. iii. pl. 11 B. fig. 8; Nicholson, Quart. Journ. Geol. Soc. vol. xxiv. p. 134, pl. 5. figs. 8–10.)

Frond consisting of two small stipes springing from a long and slender radicle, at an angle of divergence which is primitively about 15°. The base is almost always more or less rounded; and the stipes very rapidly become parallel or subparallel, being bent towards the middle line so as to diminish the primary angle of divergence. The average length of the stipes is not more than a quarter of an inch; but in rare cases more than half an inch may be attained. The width of the stipes is very uniform. The cellules are on the opposite side of the frond to the radicle, or occupy the sides of the angle of divergence; they are about thirty in the space of an inch, the denticles angular, and the cell-mouths at right angles to the axis of the stipe. The length of the radicle is from one-twelfth to one-tenth of an inch.

Fig. 6.

Didymograpsus geminus, His., from the Skiddaw Slates: *a*, an unusually large specimen, nat. size; *b*, another specimen, enlarged and with the cellules partially restored.

D. geminus is an unmistakable species, being at once recognized by the general shape of the frond (something like that of a tuning-fork), in which it differs from all other forms. *Didymograpsus* (*Graptolithus*) *indentus*, Hall (Grapt. Quebec Group, pl. 1. fig. 20), is probably a large example of this species; otherwise the form does not appear to be represented in the Silurian rocks of America. *D. geminus* is extremely abundant in some beds of the Skiddaw Slates; but it is very rare to find any specimen in which the form of the cellules is exhibited. The larger examples of the species approximate to the smaller forms of *D. bifidus*, Hall, and *D. Murchisoni*, Beck; but the shape of the cellules is sufficiently distinctive.

Loc. Skiddaw Slates: Outerside and Barff, near Keswick; Bannerdale Fell, near Mungrisedale; Thornship Beck, near Shap (upper beds). Lower Llandeilo: Cefn Gwynlle; Shelve, Shropshire.

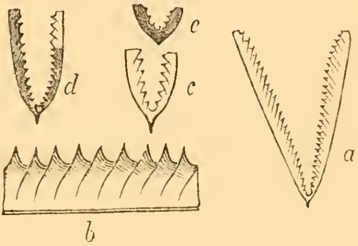
Didymograpsus bifidus, Hall, sp. Fig. 7.

Graptolithus bifidus, Hall (Grapt. Quebec Group, p. 73, pl. 1. figs. 16–18, pl. 3. figs. 9, 10).

Didymograpsus bifidus (Nicholson, Quart. Journ. Geol. Soc. vol. xxiv. p. 136).

Frond composed of two stipes diverging from a short blunt radicle at an angle of from 15° to 30° (as much as 60° in a specimen figured by Hall). The length of the stipes varies from a quarter of an inch to one inch; and the breadth varies in different parts of the stipe. Towards the base each stipe is very narrow; but it gradually expands till a width of a line may be attained (from one-eighth to one-quarter of an inch in American examples), and then a gradual diminution of width takes place towards the extremity. The celluliferous margin of each stipe is therefore curved, whilst the back is more or less completely straight. The cellules are placed on the opposite side of the frond to the radicle, or occupy the sides of the angle of divergence. The cellules are from thirty-two to thirty-six in the space of an inch, long, narrow, and slightly curved, inclined to the axis at an angle of about 45°, the cell-mouths curved and prolonged into long submucronate teeth. The base is

Fig. 7.



Didymograpsus bifidus, from the Skiddaw Slates: *a*, typical example, natural size; *b*, fragment of the same, enlarged, to show the cellules; *c*, base of another individual, with a well-developed radicle; *d*, a small example hardly separable from *D. Murchisoni*, slightly enlarged; *e*, base of another example, in which the radicle is quite rudimentary.

usually rounded, with a short obtuse radicle; but in some cases it is much more pointed, and the radicle is pretty long.

In its most typical form (as in fig. 7 *a*) the distinctness of this species can hardly be a matter of question. The smaller forms, however, of *D. bifidus*, and especially those which have a pointed base and a well-developed radicle, are certainly not distinguishable by any good characters from the younger examples of *D. Murchisoni*. This latter form, however, has hitherto proved so local in its distribution, and the fully grown forms of the two species are so distinct, that I prefer retaining all my Skiddaw-Slate specimens, in the meanwhile, under *D. bifidus*.

Loc. Upper beds of the Skiddaw Slates: Ellergill, near Milburn (abundant and very well preserved); Eggbeck, near Pooley. Rare in the lower beds of the Skiddaw Slates: Outerside, near Keswick.

Of the nine species of *Didymograpsus* which I have now described as occurring in the Skiddaw Slates, it will be seen that all, except *D. fasciculatus*, belong to the first section of the *Didymograpsi*—namely, to those in which the cellules are on the opposite side of the frond to the radicle, and the angle of divergence is not more than 180°. Indeed *D. fasciculatus* may be regarded as no more than an apparent exception to this statement, as the stipes become ultimately horizontal. We may, therefore, conclude, as far as our present materials go, that the second and third sections of *Didymograpsi* are a further and later development of the primitive type of the genus, since they are unrepresented in rocks older than the Upper Llandeilo. The primitive type, however, does not cease to be represented with the Skiddaw and Quebec groups; for *D. Murchisoni* is characteristically Upper-Llandeilo, and *D. serratulus* occurs in the Utica Slate (Caradoc) of America. There is, further, one form which would invalidate this generalization, if it were to be established in the position originally assigned to it by its author. I allude to the so-called *Didymograpsus caduceus*, originally described by Mr. Salter from Canadian specimens (Quart. Journ. Geol. Soc. vol. ix.), and afterwards figured by him from the Skiddaw Slates (*ibid.* vol. xix. p. 137, figs. 13, *a*, *b*). As I have elsewhere stated, there cannot be any hesitation in rejecting, with Hall, this species, as far as the Quebec group is concerned; and an examination of a very extensive suite of specimens from the Skiddaw Slates (including Salter's original specimens) has fully satisfied me that Hall's explanation applies also to the examples from this formation. *D. caduceus*, namely, as described by Salter, was unquestionably founded upon fragmentary examples of the four-stiped *Tetragrapsus bryonoides*, Hall, or of the hardly separable *Tetragrapsus* (*Graptolithus*) *Bigsbyi*, Hall. Recently Mr. Baily has stated that *Didymograpsus caduceus*, Salter, occurs abundantly in strata of Caradoc age in Wexford (Quart. Journ. Geol. Soc. vol. xxv. p. 160). Not having had the opportunity of seeing the specimens in question, I do not presume to express any opinion with regard to them, except that, if the name of *D. caduceus* is to be retained, it must be made to apply to forms different from those originally placed under it by Mr. Salter. It appears, however, very unlikely that the genus *Tetragrapsus*, which has hitherto not been discovered in any Upper Llandeilo deposit, should have survived into the Caradoc period; and Mr. Baily's specimens are therefore likely to be genuine *Didymograpsi*.

Mr. Carruthers (Geol. Mag. vol. v. p. 129) admits that *D. caduceus*, Salter, has certainly four branches, but still places it under *Didymograpsus*—a position obviously unsuited for it, whilst he does not recognize its unquestionable identity with *Tetragrapsus bryonoides*, which he also gives as a *Didymograpsus**.

* It being now certain that the specimens originally described by Salter as *D. caduceus* are really referable to that afterwards named by

Didymograpsus Murchisoni, Beck, sp. Pl. VII. figs. 7, 7 *a*, 7 *b*.

Graptolithus Murchisoni, Beck (Sil. Syst. p. 694, pl. 26. fig. 4).
Graptolites Murchisoni, M'Coy (Pal. Foss. ii. p. 5).

Frond consisting of two stipes springing from a mucronate base, and including between them an angle of divergence of from 10° to 15° or 20°. The stipes vary in length from a quarter of an inch up to two inches or more, proceeding from the radicle outwards and upwards with a slight curve, and being then continued to their terminations nearly in straight lines. The width of the stipes varies greatly in different individuals; but they are always narrowest at the base, expand gradually till their full width is attained, and then gradually contract towards their distal extremities. The back of the stipe, however, is never so straight as in typical examples of *D. bifidus*, Hall, and the celluliferous margin is not so strongly convex. Specimens of average size have a breadth near the base of one twenty-fourth of an inch, and in the fully-developed portion of from one to one and a half line. Gigantic individuals, however, not unfrequently occur (fig. 7 *a*) in which these same measurements are one line and a half and one-quarter of an inch respectively; and even these limits are occasionally exceeded. The base is obtusely pointed, and is furnished with a long triangular mucro or radicle, the length of which is from one to one and a half line. In the large specimens, however, the radicle is much less developed proportionally, and is blunt and obtuse. The cellules are on the opposite side of the frond to the radicle, or occupy the sides of the angle of divergence, and are from twenty-two to thirty-two in the space of an inch, having the proximal lip of the cell-apertures prolonged into long acute denticles. In the smaller specimens the cellules form an angle of about 45° with the axis, are free for about half their entire length, and have the cell-mouths somewhat curved and nearly rectangular to the axis. In the larger specimens, the cellules in the fully-developed portion of the stipe lose many of these characters, becoming more nearly horizontal or rectangular to the axis, whilst they overlap one another throughout the greater part of their length, and have the cell-apertures directed decidedly downwards, owing to the great prolongation of the proximal margin of each.

Hall *Tetragrapsus* (*Graptolithus*) *bryonoides*, Salter's specific name should have the priority, as bearing the date 1853, whereas Hall's name was given in 1857. The species, therefore, should be called *Tetragrapsus caduceus*, Salt., sp. There appears, however, to be no doubt that the form is really identical with the *Fucoides serra* of Brongniart, published in 1828. In strict justice, therefore, the species should be called *Tetragrapsus serra*, Brongn., sp.

This well-marked species has long been known to all students of Silurian geology, but has never been fully described. It is characteristically Upper-Llandeilo, and I am not aware that it occurs in any other formation. One of the most remarkable points about this form is the extraordinary disproportion in size between different individuals. Numerous intermediate examples, however, occur, connecting the smallest and largest individuals; so that there can be no doubt as to their specific identity.

Loc. Upper Llandeilo rocks of various parts of Wales, Abereiddy Bay in Pembrokeshire being one of the most noted localities. Llandeilo rocks of County Meath, in Ireland (Baily).

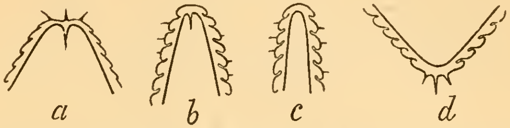
Didymograpsus divaricatus, Hall, sp. Pl. VII. figs. 4 & 4 *a*.

Graptolithus divaricatus, Hall (Pal. New York, vol. iii. Suppl. p. 513).
Dicranograpsus divaricatus, Hall (Grapt. Quebec Group, p. 57).
Didymograpsus elegans, Carruthers (in part), Geol. Mag. vol. v. pl. 5. fig. 8*a*.
Didymograpsus Moffatensis, Carruthers, Ann. & Mag. Nat. Hist. Jan. 1859.

Frond consisting of two long and narrow stipes springing from a mucronate base, attaining each a length of from two to three inches or more, and including between them an "angle of divergence" of from 90° to 130°. The base (fig. 8 *d*) is convex and rounded, and is formed by a long triangular median radicle, flanked by two shorter lateral spines, the whole three occupying a non-celluliferous space of over one line in breadth. The radicle is in its normal position on the inferior aspect of the frond, and *the cellules are on the same side of the frond as the radicle*. In this species, therefore, as in *D. sextans*, the true angle of divergence is bounded by the non-celluliferous margins of the stipes. The "radicular angle," or that on the same side of the frond as the radicle, is in this case contained between the celluliferous margins of the stipes, and varies from 270° to 230°. Each stipe is about one-fortieth of an inch in breadth at its commencement, and gradually widens out till a width of half a line may be attained. The cellules are from twenty to twenty-six in the space of an inch, their outer margins curved, convex, and nearly parallel to the axis, the denticles obtuse and rounded, and the cell-apertures forming oblique indentations or pouches which extend about halfway across the stipe, and are rounded-off internally. According to Hall, "the surface is marked by a row of small nodes placed obliquely to the direction of the axis, and situated just below and a little on one side of the bottom of the serrature."

This beautiful species (originally described by Hall from the Hudson-River group of America) is distinguished from all others by the possession of a median radicle and two lateral spines, placed on the *same* side of the frond as the cellules. *D. flaccidus*, Hall, has three smaller spines placed in a similar manner on the same side of the frond as the cellules (fig. 8);

Fig. 8.



a, base of *D. flaccidus*, Hall; *b*, base of *D. anceps*, Nich., showing the internal radicle; *c*, base of another example of *D. anceps*, in which there is no radicle; *d*, base of *D. divaricatus*, Hall, showing the radicle with its two lateral spines. All enlarged.

but the central spine of these is not the *radicle*, as is shown by the occurrence of the true radicle on the *opposite* side of the frond—this completely altering the whole relations of the parts. These anti-radicular ornamental spines of *D. flaccidus* have, however, been confounded by Mr. Carruthers with the genuine radicle with its flanking spines in *D. divaricatus*. As regards the form of the cellules *D. divaricatus* cannot be distinguished from *D. sextans*, Hall, and *D. anceps*, Nich. The former, however, of these is readily distinguished by its general form, and the latter, as I shall immediately explain, is separated by the fundamental structure of the frond.

Didymograpsus Moffatensis, Carr., and one of the specimens included under *D. elegans*, Carr., are clearly identical with one another; and both (unless figured upside down) appear to be referable to *D. divaricatus*, Hall, which bears the date of 1855, and has therefore the priority*.

Loc. Rare in the anthracitic shales of Glenkiln Burn, in Dumfriesshire (Upper Llandeilo).

Didymograpsus anceps, Nich. Pl. VII. fig. 5, 5 *a*, 5 *b*.

(Geol. Mag. vol. iv. p. 110, pl. 7. figs. 18–20.)

Frond consisting of two stipes, diverging from an initial point which may or may not be marked by the presence of a

* It is quite possible that *Didymograpsus* (*Cladograpsus*) *Forchammeri*, Geinitz, is really identical with *D. divaricatus*, Hall, in which case Geinitz's name would have to be retained, as it was published in 1852. Accepting, however, the accuracy of the figure given by Geinitz (Die Grapt. pl. 5. figs. 28, 29), the base appears to be destitute of the radicle and lateral spines so characteristic of *D. divaricatus*. The other figures of Geinitz (*ibid.* pl. 5. figs. 30, 31) are certainly referable to a different form, probably to *D. flaccidus*, Hall.

radicle. In some cases the initial point is recognized simply by the fact that it is the point of flexion of the frond, and from it the cellules point in opposite directions. In other specimens the initial point is marked by the presence of a slender radicle, the length of which varies from a mere node up to nearly one line. In all specimens which exhibit any traces of a radicle, without exception, this is on the *inferior*, whilst the cellules are on the *superior* aspect of the frond, so that the two are on opposite sides (fig. 8 *b*). The result of this is, that the "angle of divergence," properly speaking (namely, the angle formed by the stipes on the opposite side of the frond to the radicle), is in this case to be measured between the celluliferous margins of the stipes; and it varies from 340° to 355°. The "radicular angle," on the other hand, is included between the non-celluliferous margins of the stipes; and it varies from 5° to 20°. The margin of the frond opposite to the radicle is never ornamented by spines, and is simply formed by the coalescence of the bases of the first two cellules. This structure is of interest, as agreeing with *D. sextans*, Hall (at any rate, in its ordinary form), and apparently foreshadowing what we find in *Dicranograpsus*. The stipes are very little narrower at their origin than elsewhere; and they retain a pretty uniform width throughout, varying in different individuals from one twenty-fourth of an inch up to two thirds of a line. The cellules are not distinguishable in shape from those of *D. divaricatus*, Hall, and *D. sextans*, Hall. They are from twenty-five to thirty in the space of an inch, their outer margins convex and nearly parallel to the axis, their apices rounded off, and the cell-apertures forming oblique pouch-like indentations, which extend halfway across the stipe. In some specimens, the first few cellules on either side of the initial point are provided each with a short blunt spine proceeding from the centre of their outer margins. In some examples there are minute pustules or circular depressions in the centre of each denticle where it joins the body of the stipe; but this phenomenon is not constant in its occurrence. As I have already said, in the shape of the cellules *D. anceps* is not distinguishable from *D. divaricatus*, Hall (=*D. Moffatensis*, Carr.?). In all other respects, however, they are totally distinct; and they could only be confounded, as they have been (Carruthers, Geol. Mag. vol. v. p. 129), by turning *D. anceps* upside down. In the first place, in *D. anceps* the radicle and cellules are on opposite sides of the frond, whilst in *D. divaricatus* they are on the *same* side. In addition to this very obvious and, indeed, fundamental distinction, the following points of difference may be mentioned:—In *D. anceps* the "angle of divergence," as measured between the stipes on the side opposite to the radicle, is from 340° to 355°, the radicle is not furnished with lateral spines, and the width of the stipes is extremely uniform in any given individual. In *D. divaricatus*, on the other hand, the "angle of divergence," measured in the same way, is from 90° to 130°, the radicle is invariably flanked by two lateral spines, and the stipes are considerably narrower at their commencement than towards their distal extremities. These points of difference should be sufficient to prevent in future any confusion between two species which in reality belong to two different *sections* of the *Didymograpsi*.

Loc. Upper Llandeilo, Dobbs's Linn, near Moffat.

Didymograpsus flaccidus, Hall, sp. Pl. VII. figs. 6, 6 *a*, 6 *b*, 6 *c*.

Graptolithus flaccidus, Hall (Grapt. Quebec Group, Suppl. p. 143, pl. 2. figs. 17–19).
Didymograpsus flaccidus (Nicholson, Geol. Mag. vol. iv. p. 110).
Didymograpsus elegans, Carruthers (in part), Geol. Mag. vol. v. pl. 5. figs. 8 *b*, 8 *c*.

"Frond consisting of two slender, linear, flexuous stipes, which are widely divergent from a small, short, obtuse radicle" (Hall). The stipes are about one fiftieth of an inch in breadth at their commencement, but widen out till a width of one twenty-fifth of an inch may be attained, and they not unfrequently reach a length of several inches without showing any signs of a termination. The proper "angle of divergence" of the stipes, as measured on the opposite side of the frond to the radicle, is from 280° to 320°, whilst the "radicular angle" is from 40° to 80°. The radicle varies in length from one twenty-fourth of an inch up to one tenth, being sometimes long and pointed, at other times short and obtuse, whilst it is invariably situated on the inferior or concave margin of the frond. The margin of the frond immediately opposite to the radicle is adorned by three short and delicate processes or spines—one directly opposed to the radicle, and one springing from the first cellule on each side (fig. 8 *a*). These spines are simply ornamental appendages, so to speak, and have nothing whatever to do with the true *radicle*, from which they must be carefully distinguished. The cellules are on the opposite side of the frond to the radicle, from twenty-five to thirty in the space of an inch, averaging twenty-eight, narrow, their outer margins straight or very slightly curved, inclined to the axis at a very low angle (about 20°), their apices usually gently rounded, and the cell-apertures running partially across the body of the stipe.

As to the complete identity of this beautiful species with the *Graptolithus flaccidus* described by Hall from the Utica Slate, there can be no doubt; and in this opinion I am fully borne out by Prof. Harkness, who has examined some of my specimens. Our British specimens have been placed by Mr. Carruthers under his *D. elegans*, which seems to be founded partly upon *D. divaricatus*, Hall, and partly upon *D. flaccidus*. The specimens figured by Mr. Carruthers as *D. elegans*, and really belonging to *D. flaccidus*, are figured upside down (Geol. Mag. vol. v. pl. 5. figs. 8 *b*, 8 *c*).

Our British examples, however, agree with *D. flaccidus*, as described and figured by Hall, in the general shape of the frond, in the position of the radicle, in the shape of the cellules and in their number to the inch, and, in fact, in every essential respect, except in the fact that the American specimens appear to want the small spines which are found opposite to the radicle in our form. These, however, are not constantly preserved, even in the British specimens; and even if constantly wanting in the American examples, their absence would not be enough of itself to constitute a specific distinction. From *D. divaricatus*, Hall, the present species is distinguished by the fact that the cellules are on the opposite side of the frond to the radicle, the reverse being the case in the former; whilst the characters of the cellules in the two show several decided points of difference. From *D. anceps*, Nich., in which the cellules and the radicle hold the same relative position as in *D. flaccidus*, the latter is distinguished by the much greater length and tenuity of the stipes, as well as by the different characters of the cellules.

I have only to add that, in connexion with the fully grown fronds of this species, there often occur numerous young forms in different stages of development, commencing with those which exhibit only one or two cellules on each side of a central radicle (Pl. VII. fig. 6 *c*). Even in these small forms, however, the three minute spines opposite to the radicle can be recognized.

Loc. Upper Llandeilo rocks of Dobbs's Linn, and Hart Fell, near Moffat.

Didymograpsus sextans, Hall, sp. Fig. 9.

Graptolithus sextans, Hall (Pal. New York, vol. i. p. 273, pl. 74. figs. 3 *a–e*).
Diplograpsus (?) *sextans*, M'Coy (Pal. Foss. part 2, p. 9).
Graptolithus sextans, Salter (Quart. Journ. Geol. Soc. vol. v. p. 17, pl. 1. fig. 10).
Dicranograpsus sextans, Hall (Grapt. Quebec Group, p. 57).
Didymograpsus sextans, Baily (Characteristic British Fossils, pl. 9. figs. 6 *a–d*).

Frond consisting of two small stipes, generally from four to five lines each in length, with an average breadth of about half a line, diverging from a mucronate base at an angle of about 60°. The base is rounded, and is seen, in the few specimens which are well preserved, to be provided with two

Fig. 9.

Didymograpsus sextans: *a*, a specimen slightly enlarged and with the cellules partially restored; *b*, base of the same, enlarged.

lateral spines, and sometimes with a central minute spine or radicle, though this latter can only rarely be detected. The radicle is, as usual, on the inferior aspect of the frond, and the cellules are situated on the *same* side—a peculiarity found in no other *Didymograpsus* except *D. divaricatus*, Hall. The "angle of divergence" is therefore included between the non-celluliferous margins of the stipes; and it is almost always about 60°. The "radicular angle" is bounded by the celluliferous margins of the stipes, and is, of course, about 300°. The cellules are from thirty to thirty-five in the space of an inch, and the first two are coalescent by their bases, as in *D. anceps*. In all essential respects the cellules are identical with those of *D. divaricatus* and *D. anceps*. The outer cell-walls, namely, are curved and subparallel with the axis; the denticles are obtusely rounded off; and the cell-apertures form oblique indentations extending about halfway across the stipe. These, at any rate, are the characters of the cellules in our British specimens, in those few examples in which they admit of examination, as they rarely do. In Hall's original description the cellules are said to terminate in "slender mucronate points;" but some error must undoubtedly have been made upon this head. This is rendered certain by the fact that Hall has subsequently placed *D. sextans* in the genus *Dicranograpsus* along with *D. divaricatus*, expressly upon the ground of the similarity in the shape of the cellules, whilst he has figured the latter with cellules such as I have described above.

The propriety of placing *D. sextans* in the genus *Dicranograpsus* as this genus is understood by British palæontologists, may still be looked upon as an open question. In none of the many specimens which have passed through my hands have I observed any thing more than the coalescence of the first two cellules by their bases. This, though perhaps an approximation to *Dicranograpsus*, occurs also in *D. anceps*, and is not sufficient to require the removal of the species from *Didymograpsus*. Recently, however, Mr. John Hopkinson has been kind enough to send me drawings of some specimens which appear to belong, beyond a question, to *D. sextans*, but in which this amalgamation has gone further. In these, namely, whilst the bulk of the frond has all the characters of *D. sextans*, there is an exceedingly short basal portion formed by a coalescence of the first two or three cellules on each side. Whether this form is identical with *Graptolithus furcatus*, Hall (Pal. New York, vol. i. pl. 74. figs. 4 *a–h*), or whether it should be looked upon as a transition between *D. sextans* and *Dicranograpsus* proper, I am unable to say. *D. sextans*, in its typical form, as above described, is easily recognizable by the shortness of the stipes, the constancy of the angle of divergence, the presence of the radicle and the cellules on the *same* side of the frond, and the characters of the cellules.

Loc. Abundant, but badly preserved, in the anthracitic shales of Glenkiln Burn in Dumfriesshire, and Cairn Ryan in Ayrshire; also in several localities in Ireland (Baily).

EXPLANATION OF PLATE VII.

Fig. 1. *Didymograpsus patulus*, Hall, nat. size. From the Skiddaw Slates of Outerside, near Keswick.

1 *a*. Portion of *D. patulus*, enlarged, to show the cellules, after Hall.

Fig. 2. *Didymograpsus extensus*, Hall, nat. size. From the Skiddaw Slates of Outerside, near Keswick.

2 *a*. Fragment of *D. extensus*, enlarged, to show the cellules, after Hall.

Fig. 3. *Didymograpsus serratulus*, Hall, nat. size. From the Skiddaw Slates of Outerside, near Keswick.

3 *a*. Base of *D. serratulus*, enlarged, after Hall.

3 *b*. Base of *D. serratulus*, from another specimen, from the Skiddaw Slates of Outerside. Enlarged.

3 *c*. *D. serratulus* (?), from the Skiddaw Slates of Outerside, natural size. The angle of divergence is much greater in this than in ordinary specimens.

3 *d*. *D. serratulus* (?), from the Skiddaw Slates of Thornship Beck, near Shap. The angle of divergence in this specimen is much less than in ordinary specimens. Natural size.

Fig. 4. *Didymograpsus divaricatus*, Hall, slightly restored from a Dumfriesshire specimen.

4 *a*. Base of a specimen of *D. divaricatus*, from the Upper Llandeilo rocks of Dumfriesshire. Enlarged.

Fig. 5. *Didymograpsus anceps*, Nich., slightly enlarged. Upper Llandeilo rocks of Dobbs's Linn, near Moffat.

5 *a*. Base of another specimen of the same, enlarged. In this specimen there is no radicle.

5 *b*. Base of another specimen of the same, in which a radicle is present: enlarged.

Fig. 6. *Didymograpsus flaccidus*, Hall, natural size: From the Upper Llandeilo rocks of Dobbs's Linn, near Moffat.

6 *a*. Base of another specimen of the same, enlarged, showing the three small spines opposite to the radicle.

6 *b*. Fragment of the same, enlarged, to show the cellules.

6 *c*. Germs of *D. flaccidus*, nat. size.

Fig. 7. Small specimen of *Didymograpsus Murchisoni*, Beck, nat. size. From the Upper Llandeilo rocks of Abereiddy Bay, in Pembrokeshire.

7 *a*. Large specimen of *D. Murchisoni*, from the same locality, nat. size.

7 *b*. Base of another small specimen of *D. Murchisoni*, enlarged. The base is considerably more obtuse and rounded in this specimen than in fig. 7.

XXXVII.—*List of Species in a small Collection of Butterflies from the South Seas.* By Arthur Gardiner Butler, F.L.S. &c.

A collection of Diurnal Lepidoptera has recently been sent to the British Museum by Julius Brenchley, Esq., which, though small, contains several interesting novelties. The species are all referable to two of the five Rhopalocerous families, and the majority of them to the subfamily Danainæ.

Family **Nymphalidæ**, (Westwood) Bates.

Subfamily *Danainæ*, Bates.

Genus Euplœa, Fabricius.

1. *Euplœa anthracina.*

Euplœa anthracina, Butler, P. Z. S. p. 280. n. 39, p. 281. fig. 1 (1866).

One example. South-Sea Islands.

2. *Euplœa Brenchleyi*, sp. nov.

♂. Alæ supra saturate fuscæ, area apicali alba; margine late fusco; stria infra ramum primum medianum sericea: posticæ fuscæ, area externo-anali pallidiore; costa sericea dilutiore.

Alæ subtus pallidiores, area externa alba: anticæ punctis tribus mediis violaceis quorum maximo discoidali et puncto discali albo: posticæ costa pallide fusca; macula discoidali serieque punctorum quinque discalium in serie angulata violascentium; punctis consuetis basalibus albis: corpus nigrum, albo punctatum.

♀ differt supra area anticarum alba duplo latiore et area externa posticarum late alba; subtus stria anticis interna alba.

Exp. alar. unc. 3, lin. 2.

Five specimens (4 ♂, 1 ♀). South-Sea Islands.

Resembles another species in the same collection, which has a more powerful build; it is, however, allied to *E. Lapeyrousei* and *E. sepulchralis.*

3. *Euplœa Schmeltzi.*

Euplœa Schmeltzi, Herrich-Schäffer, Stett. ent. Zeit. 30 Jahrg. n. 1–3, p. 70. n. 4, pl. 1. fig. 8 (1869).

One specimen. (Upolu?) South-Sea Islands.

Differs from the figure in the 'Zeitung' in having no submarginal spots above or below; but in the subapical spots of the front wings, and the central spots on the under surface, it exactly agrees with Dr. Herrich-Schäffer's species.

4. *Euplœa Helcita.*

Euplœa Helcita, Boisduval, Bull. Soc. Ent. France, p. 156 (1859).

One individual. South-Sea Islands.

The *E. Eschscholtzii* of Felder, as figured by Dr. Herrich-Schäffer, is only a dwarfed specimen of this species, which is a race of the following.

5. *Euplœa Eleutho.*

Danais Eleutho, Quoy & Gaimard in Freycinet's Voy. pl. 83. fig. 2 (1815).

Three examples (♀). South-Sea Islands.

This is distinct from *E. Angasii* of Felder, which I erroneously referred to it in my paper on this subfamily, published in the 'Transactions of the Entomological Society.'

6. *Euplœa Herrichii.*

Euplœa Herrichii, Felder, Reise der Novara, p. 344. n. 477, pl. 39. figs. 3, 4 ("1865") = *E. Proserpina*, Butler, in P. Z. S. p. 300 (1866).

Two specimens. Fiji Islands.

As the question of priority with regard to the species described in the 'Novara' seems unlikely to be satisfactorily settled, I am quite willing, for the benefit of science, to withdraw my claim. There are, however, three interesting questions respecting the publication of the second part of the work which as yet I have not seen answered:—First, if the letterpress for the part was ready with the plates, why did the notice on the cover of the preceding part state that the *plates* for the succeeding part (and not the *plates* and *letterpress* or the *part* itself) would shortly be ready? Secondly, if the uncoloured part was to be had upon application to the publisher in 1865, there is still no published evidence that any copies were publicly sold that year. Thirdly, if such copies were sold, were they obtained by favour? and was the uncoloured form the complete form of the work, since some of the figures on the plates are not recognizable without colour? I should say not.

7. *Euplœa Lorenzo*, sp. nov.

Affinis *E. Jessicæ.* Alæ supra nigræ, cærulescentes: anticæ striola inter nervulos secundum et tertium medianos alba; stria interno-discali virescente: posticæ area costali fusca; maculis septem discalibus velut in *E. Jessica*, sed albis.

Alæ subtus nigræ, fuscescentes, purpureo micantes: anticæ macula discoidali, puncto pone eam discali striolaque superna discali albis; area interna fusca: posticæ macula punctisque basalibus, maculis tribus mediis serie subrecta positis, puncto adjacente minutissimo maculisque septem supernis albis: corpus fuscum, albo punctatum.

Exp. alar. unc. 3, lin. 7.

One specimen. South-Sea Islands.

Closely allied to *E. Jessica*, Butler (Lepid. Exot. iii. p. 20, pl. 8. fig. 3), but differing in having only two small spots on the upper surface of the front wings and in the creamy-white colour of all the spots.

8. *Euplœa imitata*, sp. nov.

♂. Alæ supra saturate fuscæ: anticæ area apicali-externa alba opalescente, puncto adjacente costali albo; area anali ochracea; costa ochraceo tincta; macula infra nervulum primum medianum ovali roseo-alba; margine externo tenuissime nigro-fusco: posticæ plaga permagna pyriformi subcostali cellam partim tegente ochraceo-albida; area costali sericea; area externa ochracea; plicis internervularibus albo acuminatis; maculis octo discalibus obsoletis albis: corpus nigro-fuscum; capite et prothorace albo punctatis.

Alæ subtus pallidiores: anticæ area interna sordide albida; macula superna ovali obsoleta, altera infra ramum secundum medianum rotundata, roseo-alba; punctis duobus submarginalibus albis: posticæ fuscæ, plaga subapicali permagna nebulosa obscuriore; area externa albicante, punctis decem submarginalibus decrescentibus albis, purpureo cinctis: corpus nigrum, albo punctatum.

Exp. alar. unc. 3, lin. 3.

One specimen. South-Sea Islands.

Allied to *E. assimilata* of Felder, which I only know from the figure, but which looks very like the male of *E. Eurypon* of Hewitson.

Genus Danais, Latreille.

1. *Danais Archippus.*

Papilio Archippus, Fabricius, Ent. Syst. iii. p. 49. n. 151 (1793).

Three examples (♂). South-Sea Islands.

I cannot account for the existence of this species in the collection. It generally comes from the United States and St. Domingo.

2. *Danais insolata*, sp. nov.

♂ ♀. Alæ supra fuscæ, disco obsolete fulvo strigoso: anticæ area apicali nivea, a venis (præcipue ad angulum ani) persecta, a plaga oblonga costali interrupta et ad apicem in puncta quinque marginalia separata: posticæ fascia marginali nivea, a venis in maculas octo quadratas subgeminatas divisa; margine extremo nigro.
Alæ subtus pallidiores: posticæ magis fulvescentes, maculis marginalibus supernis haud geminatis.
Exp. alar. unc. 2, lin. 11.

Two specimens (♂ ♀). South-Sea Islands.

Belongs to the *affinis* group, but is very distinct from all the species hitherto described.

3. *Danais Melissa.*

Papilio Melissa, Cramer, iv. pl. 377. figs. C, D (1782).

Two specimens. Upolu.

Subfamily *Satyrinæ*, Bates.

Genus Xois, Hewitson.

Xois Sesara.

Xois Sesara, Hewitson, Trans. Ent. Soc. ser. 3. ii. pt. 4. p. 282, pl. 17. figs. 3, 4 (1865).

Fifteen specimens. Ovolo (Fiji Islands).

Genus Melanitis, Fabricius.

Melanitis Leda.

Papilio Leda, Linnæus, Syst. Nat. i. p. 773. n. 150 (1766).

One specimen. South-Sea Islands.

The single individual in the collection belongs to the *Solandra* type of the species.

Subfamily *Nymphalinæ*, Bates.

Genus Junonia, Hübner.

Junonia Villida.

Papilio Villida, Fabricius, Mant. Ins. p. 35. n. 366 (1787).

One example. South-Sea Islands.

Genus Diadema, Boisduval.

Diadema Bolina.

Papilio Bolina, Linnæus, Mus. Lud. Ulr. et Syst. Nat. i. p. 781 (1766).

Sixteen specimens (♂ ♀). South-Sea Islands.

There are three forms of this species in the collection, viz. *P. Lasinassa* ♀, *P. Antigone* ♂ ♀, and a female resembling the male of *P. Jacintha.*

Subfamily *Acræinæ*, Bates.

Genus Acræa, Fabricius.

Acræa Andromacha.

Papilio Andromacha, Fabricius, Syst. Ent. p. 466. n. 102 (1775).

One specimen. South-Sea Islands.

Family **Papilionidæ**, (Doubl.) Bates.

Subfamily *Pierinæ*, Bates.

Genus Pieris, Schrank.

Pieris Teutonia.

Papilio Teutonia, Fabricius, Syst. Ent. p. 474. n. 137 (1775).

One specimen (♂). South-Sea Islands.

Genus Callidryas, Boisduval.

Callidryas lactea, sp. nov.

♂ ♀. Alæ supra albæ, apice fusco tincto; puncto disco-cellulari maris minutissimo, fœminæ majore geminato, fusco: corpus cinereum; capite subvirescente.

Alæ subtus pallide ochraceæ, ochreo striolatæ; puncto minuto disco-cellulari annulari fuscescente: anticæ area interna albicante: corpus albidum, antennis ochraceis.

Exp. alar. unc. 2, lin. 7.

Three specimens (2 ♂, 1 ♀). South-Sea Islands.

This species, which has hitherto come from Australia, has been looked upon as the *C. Thisorella* of Boisduval; the latter, however, is an extreme form of *C. Pyranthe.*

Genus Terias, Swainson.

Terias Hecabe.

Papilio Hecabe, Linnæus, Syst. Nat. i. p. 763 (1766).

One specimen. South-Sea Islands.

A variety with narrow margin to hind wings.

XXXVIII.—*On new Diurnal Lepidoptera.* By A. G. Butler, F.L.S. &c.

Family **Nymphalidæ**, Westwood.

Subfamily *Satyrinæ*, Bates.

Genus Anchiphlebia, Butler.

Anchiphlebia ornata, sp. nov.

♀. Alæ supra fuscæ: anticæ ocellis quatuor permagnis nigris, albo pupillatis, ochraceo cinctis: posticæ maculis quinque ocellaribus cæruleis (pupillis plus minus distinctis albo squamosis), nigro cinctis, ochraceo limbatis; fundo areæ apicalis lilacino: corpus fuscum.

Alæ subtus ochreæ, velut in *A. Hela* striolatæ et lineatæ.

Exp. alar. unc. 3, lin. 3.

Hab. Cayenne (*Deyrolle*). ♀. Coll. Druce.

This is the finest species in the genus; it is not likely to be the female of *A. Hela*, to which it is allied, as the other species of *Anchiphlebia* are alike in both sexes.

Subfamily *Nymphalinæ*, Bates.

Genus Pyrrhogyra.

Pyrrhogyra Ophni, sp. nov.

♂. Alæ supra nigerrimæ, fascia communi media nivea, anticarum ad nervulum secundum medianum oblique disrupta: posticæ sinuatæ, ciliis albis; puncto ad angulum analem rubro: corpus nigrum.

Alæ subtus niveæ, area basali cinereo tincta: anticæ stria costali et disco-cellulari nigro limbata, coccinea; vena mediana nigro limbata; fascia postmedia bifurcata nigra, furca inferiore in nervulo secundo mediano posita, superiore ad costam curvata et striam coccineam includente, serie submarginali macularum sub octo albarum inæqualium; margine externo late olivaceo, stria obscuriore antemarginali: posticæ fascia disco-costali nigro-fusca, lineam sinuatam coccineam includente, hac ad angulum ani maculari albo bipupillata; disco submarginali fusco tincto, maculis sex ovalibus albis, primo et quarto minimis; linea antemarginali nigra: corpus albidum.

Exp. alar. unc. 2, lin. 11.

Hab. Minas Geraës (*Rogers*). Two specimens. Coll. Druce.

Allied to *P. Tiphus* of Linnæus, but quite distinct.

Genus Tanaëcia, Butler.

Tanaëcia Orphne, sp. nov.

♂. Alæ supra nigro-fuscæ, purpureo tinctæ; striolis basalibus velut in *T. Trigerta*, nigris; serie angulata macularum quatuor albidarum postmedia; maculis sex discalibus elongatis, nigris, introrsum a lunulis tenuissimis albis limbatis: posticæ punctis sex discalibus nigris; maculis octo submarginalibus nigris extrorsum a punctis albidis limbatis, duabus apicalibus introrsum albo marginatis: corpus nigro-fuscum.

Alæ subtus fere velut in *T. lutala*, striolis autem basalibus velut supra: corpus ochraceum.

Exp. alar. unc. 2, lin. 5.

Hab. Sarawak (*Lowe*). Two specimens. B.M.

Intermediate in character between *T. lutala* and *T. Trigerta*, but in general appearance and colour very unlike either.

Family **Erycinidæ**.

Subfamily *Nemeobiinæ*, Bates.

Genus Abisara, Felder.

Abisara Thiusto, Hewitson.

♂. Alæ supra nigerrimæ: subtus ferrugineæ, apice anticarum aurantiaco, seriebus quatuor macularum nigrarum, extrorsum cæruleo marginatarum, transversalibus arcuatis; maculis tribus subapicalibus in anticis albicantibus.

Exp. alar. unc. 1, lin. 8.

Hab. Sarawak (*Lowe*). ♂. Coll. Druce. ♀. B.M.

Allied to *T. Drupadi* of Horsfield (*P. Haquinus*, Fabr.), but quite black above, without a ferruginous patch at the apex, and with white subapical spots as in the female.

Abisara Zemara, sp. nov.

Affinis *A. Haquino*, differt alis supra omnino obscurioribus; plaga apicali anticarum maris restricta brunnea, fœminæ ferruginea (haud alba): subtus maculis majoribus nigris.

Exp. alar. ♂ unc. 2, ♀ unc. 2, lin. 3.

Hab. Sarawak (*Lowe*). ♂ ♀. Coll. B.M.

A representative of *A. Haquinus*.

Subfamily *Erycininæ*, Bates.

Genus Lymnas, Blanchard.

Lymnas Jesse, sp. nov.

♀. Simillima *Uraneidi hyalinæ* ♀, alis subhyalinis, lilacino tinctis, venis omnibus late nigrescentibus; anticis dimidio apicali marginibusque nigrescentibus; fasciola punctoque subapicalibus mar-

gines haud attingentibus albis: posticæ margine externo nigrescente: corpus fuscum, palpis aurantiacis.
Alæ subtus albicantes, aliter velut supra.
Exp. alar. unc. 1, lin. 11.

Hab. Venezuela. ♀. Coll. Kaden in Coll. Druce and in Coll. B.M.

Unlike any other species in the genus.

Genus LYROPTERYX, Westwood.

Lyropteryx Olivia, sp. nov.

♀. Alæ supra nigræ: anticæ fascia maculari, mediocri, angulata, a costa ad nervulum secundum medianum oblique currente, hinc autem marginali, coccinea: posticæ fascia paululum latiore a venis nigris intersecta et introrsum dentata, coccinea: corpus fuscum, collo rufescente.
Alæ subtus pallidiores, venis distinctioribus; maculis basalibus coccineis, velut in *L. Apollonia* ♀ positis.
Exp. alar. unc. 2, lin. 5.

Hab. ——? Coll. Kaden in Coll. Druce.

Allied to *L. Apollonia*, but differing from the female of that species in having a scarlet band in the front wings, and the basal spots below without any lilacine reflection. This species can scarcely be the female of *L. Lyra*, as the scarlet band only reaches the outer margin just above the second median branch, and is not diffused outwardly towards the apex.

Genus EMESIS, Fabricius.

Emesis Zela, sp. nov.

♂. Alæ supra fuscæ, characteribus basalibus linea angulata pone medium multifracta lineaque indistincta armillata submarginali, nigro-fuscis: posticæ striolis basalibus lineisque tribus multifractis discalibus, nigro-fuscis; plaga subapicali aurantiaca: corpus fuscum.
Alæ subtus fulvæ, striolis indistinctissimis ferrugineis; area interna anticarum pallidiore nigro maculata.
♀. Alæ supra fulvo-fuscæ, characteribus basalibus lineisque tribus discalibus macularibus, nigris: subtus pallidiores, fascia angulata pone medium anticarum flavida; maculis marginis interni nigris, aliis ferrugineis.
Exp. alar. ♂ unc. 1, lin. 7; ♀ unc. 1, lin. 5.

Hab. ♂ ♀, Venezuela, Coll. Druce; Mexico, Coll. B.M.

Not closely allied to any described species.

Genus CHARIS, Hübner.

Charis Libna, sp. nov.

♂. Alæ supra albæ, stria basali obliqua et costa fuscis; margine

externo late fusco, anticarum maculas duas albas, posticarum unam includentibus; linea submarginali plumbea: corpus fuscum.
Alæ subtus fere velut supra, macula autem discali posticarum magis elongata, striolaque anali alba: corpus albicans.
Exp. alar. unc. 1.

Hab. Mexico? Coll. Kaden in Coll. Druce.

Very like some species of *Bœotis* in pattern, and unlike any other *Charis* that I have seen.

Genus Stalachtis, Hübner.

Stalachtis Evelina, sp. nov.

♂. Affinis *S. Phædusæ*, maculis autem anticarum hyalinis latioribus et omnino majoribus, areola solum interna violacea; striola anali aurantiaca tenuiore, stria posticarum marginali tenuissima areaque costali fusca: corpus fuscum.
Exp. alar. unc. 1, lin. 11.

Hab. ——? Coll. Kaden in Coll. Druce.

Allied to *S. Phædusa*, but perfectly distinct from that species.

XXXIX.—*A word in explanation of a passage occurring in my "Concluding Observations on the Parasitism of* Rhipiphorus paradoxus." By Frederick Smith.

I have read, with some degree of surprise and also with much regret, the remarks of my friend Mr. Murray on an observation in my "Concluding Observations on *Rhipiphorus*." The passage is as follows:—"The last paragraph of the postscript is entirely suppositional. Mr. Murray has not shown me any of his specimens," he having stated in his former paper that he had had that pleasure. I omitted to allude to this as being on his part a lapse of memory; and possibly this may have impressed others in the same way as it did my friend.

Nothing could have been further from my mind than to imply, in the most remote degree, the slightest doubt of his veracity. I alluded solely to the fact, which at the time was impressed upon my mind, that he had failed to fulfil his previous expressed intention. Mr. Murray has now shown me the pupæ &c. alluded to; but I am still quite unable to recall to my mind any previous examination of them: it is therefore quite certain that there is a lapse of memory on one side or the other. Mr. Murray having given publicity to his feelings on the subject, I think it is necessary on my part publicly to disclaim any intention of expressing a doubt of his veracity. Any statement made by Mr. Murray is, and always has been, to me a guarantee for its truth.

XL.—*Notes on* Myriosteon Higginsii. By Dr. J. E. Gray, F.R.S.

On the 12th of April 1864, I described, at the Zoological Society, a new form of animal under the name of *Myriosteon Higginsii*, probably indicating a new group of Echinodermata. (See Proc. Zool. Soc. 1864, p. 164.)

The specimen described had been generally regarded as the tail of a Ray, and some considered it a shell of a gigantic Foraminifer or the coral of a Polyzoan; but I was induced to believe, on account of the various pores and perforations on its surface, that it indicated a new group of radiated animals allied to *Asterias*.

I was satisfied that it could not be the tail of a Ray; for that consists of vertebræ covered with muscle, which is itself protected by a skin; whilst the specimen under examination is a hollow, elongated, compressed, rigid, bony cone, covered with hard concretions, and not at all flexible, or capable of movement like the tail of a fish.

I then stated that I did not believe it was "a part of any vertebrated animal." This is the part of my communication I wish to correct.

Having been requested by my friend Dr. E. Perceval Wright to allow him to examine a fragment under the microscope, when it was cut off I was much struck with the great similarity of the inner surface of the tube and the calcareous granulation to bone; and on consideration, I am now inclined to believe that it is part of a fish, and most probably, as they are the only ones which have a granulated skin, part of a cartilaginous fish; but the external surface of the tube is much harder and bone-like than the skeletons of these animals: it is probably an appendage of the head, like the beak of a sawfish.

On showing it to my friend Mr. Carter, he stated that he had found a somewhat similar specimen on the coast of Arabia, and that he thinks it was attached to the head of a kind of Ray. Unfortunately, he does not recollect to whom he gave his specimen, but will search for the description in his journal on his return home; and he believes it to be a part of the nasal bones.

I may observe it differs from the saw of the sawfish in being of a harder substance. Unfortunately, the state of my eyes, ever since the accident which occurred to them during the fire at the bookbinders of the Museum, has not allowed me to examine it under a microscope; but I have furnished Prof. Kölliker, Dr. Günther, Dr. Perceval Wright, and Mr. Carter with fragments of it, which they have undertaken to examine; and I hope one or more of them will publish the results of their examination.

The fish of which it forms a part is at present unknown to naturalists; and therefore the name of *Myriosteon Higginsii* may be retained.

Since the above was written, Prof. Kölliker and Dr. Günther have sent me a preparation of the specimen mounted as a slide in Canada balsam; and they have no doubt it is part of a cartilaginous fish. They have now decided that it is one of the three or five bony tubes which strengthen and support the beak of the sawfish (*Pristis*), and thus confirm Mr. Carter's account; but how these tubes became so completely separated from each other and from the other bones of the beak is difficult to imagine, and shows the great power of the sun in tropical regions.

British Museum, April 7, 1870.

XLI.—*Researches on the Freshwater Crustacea of Belgium.* (Second and Third Parts.) By Félix Plateau*.

In the present day we have witnessed the appearance of many works on the freshwater Crustacea. In England especially we may cite the researches of Messrs. Baird, Lubbock, Brady, Norman, &c., a portion of which have been published in this journal. After these important memoirs and those relating to the same subject which have appeared in Germany, Sweden, and elsewhere, nothing remained for me, so to speak, but to glean the details which have been neglected by preceding carcinologists.

Genus *Daphnia*.—It seemed to me that it would be useful to make a complete study of the dermal skeleton of the *Daphniæ*, which has hitherto been very imperfectly known; I have endeavoured to apply to it the methods of analysis of MM. Milne-Edwards, Spence Bate, and others, and to compare it as far as possible with the cutaneous envelope of the Decapoda.

The body includes three parts—the head, thorax, and abdomen. The portion of the valves and of the test which covers the apparent head answers to the *carapace* or *scapular ring* of the higher Crustacea; the *cardiac region* is represented by the triangular piece which covers the heart, and the *branchial* region by the valves.

* Mém. de l'Acad. Roy. de Belgique, Mém. des Savants étrangers, tome xxxv. Abstract communicated by the Author.

The head has undergone a remarkable curvature, which separates certain parts and brings others nearer together. The cephalic ring presents the median region (stomachal region of Desmarest), covering the anterior part of the digestive tube; and we may recognize the existence of lateral regions. The facial regions are:—the *frontal* region, in the middle, much reduced in size and covering the organ of vision (it is developed into a rostrum only in *D. mucronata*); and the *orbital* regions on each side of this.

We may count as cephalic somites:—the first, characterized by the presence of the eyes; the second, by the antennules (*rami*); the third, by the antennæ (smaller antennæ of Strauss), and its posterior margin bears the labrum; the fourth is marked by the protognaths (mandibles), and bears the labium, whilst its hypertrophied epimera constitute the valves, as MM. Milne-Edwards and G. O. Sars have already shown.

The thorax, which, like a great part of the abdomen, is enclosed between the valves, includes six somites: there is a fifth somite bearing the deutognaths (maxillæ), and a sixth bearing the tritognaths (first pair of feet, of authors) and terminating the anterior pereion. The posterior pereion is formed by four somites, each bearing a pair of pereiopods.

The abdomen consists of six somites, namely:—the eleventh, twelfth, and thirteenth; the fourteenth, provided with mamillæ which close the incubatory cavity; the fifteenth, bearing the caudal setæ; and the sixteenth, or last, which is a true *telson*.

Hitherto we have had scarcely any exact data as to the moulting of the Cladocera. I have been able to observe this phenomenon in the female of *D. mucronata*. A long transverse fissure is formed along the branchio-cardiac furrow which separates the valves from the head; and the scapular buckler splits along the median line or dorsal crest of the valves. The head bends down in front, and a new cephalic extremity makes its appearance towards the back through the transverse fissure. The *Daphnia* shakes itself rapidly; the antennules escape from the old ones as if these were actual sheaths; then the animal, by a few last efforts, finally escapes from its old skin through the longitudinal opening of the crest of the valves. The phenomenon takes place with extreme rapidity, the whole change only lasting two seconds.

The circulatory apparatus presents some curious peculiarities. Thus the venous sinus which surrounds the heart is by no means always circular, as has been supposed. In *D. pulex*, when seen from the dorsal surface, it is polygonal, with seven sides; at each systole these seven faces become strongly concave, at each diastole they return to their rectilinear form.

I have found in Belgium seven species of *Daphnia*, a single *Bosmina* (*B. longirostris*, Baird), and a single *Polyphemus* (*P. oculus*, Müll.). The last is excessively rare.

Copepoda.—I have made the following observations upon the dermal skeleton. M. Leydig has stated that the cuticle (epidermis) contains no calcareous deposit; I have demonstrated its presence chemically. The canals which traverse the cuticle in the higher Arthropoda are visible here only at the posterior margin of certain thoracic segments. The material which colours the skin is situated in the soft non-chitinous membrane (corium), and is of a granular nature. The animal probably lives at its expense during periods of forced abstinence from food; for, according to my experiments and those of M. Zenker, the colour disappears when the animal is made to fast. The blue or green colouring-substance undergoes no change by the action of bases; it becomes reddish by the action of acids, and in this case bases do not bring it back to its original tint.

The Copepoda are often indebted for other colours to their residence in naturally coloured waters. Following the example set by B. Prévost with other animals, I put some Cyclopidæ into water reddened by carmine; in the course of six days they acquired a rose-colour, and the colouring-matter was to be seen in the digestive tube, in the envelope of the oviferous sacs of the females, and in the interior of the bodies of the parasitic Infusoria. All these observations prove that in this group of Crustacea, notwithstanding the contrary opinion of Müller, colour can never be regarded as a specific character.

The dermal skeleton of the genera *Cyclopsina*, *Canthocamptus*, and *Cyclops*, when subjected to the same analysis as that of the *Daphniæ*, shows six cephalic somites (of which the tergal portions become amalgamated to form a carapace), four thoracic somites, and six abdominal somites, including the *telson.* The appendicular organs are—a pair of antennules, a pair of antennæ, a pair of protognaths, three pairs of maxillipeds, four pairs of thoracic feet or pereiopods (each including an endopod and an exopod), and, lastly, a pair of uropods.

The muscular system, which is highly developed, merited a careful examination. Histologically the muscles are like those described by M. Leydig in *Branchipus*; that is to say, they are composed of a transparent envelope and a contractile sarcode consisting of cuneiform elements closely interlaced. For the sake of brevity, I shall not reproduce the description of the musculature of the body; but I may indicate one peculiarity: in the antennæ, the pereiopods, and the uropods, whilst we see in each moveable joint a flexor muscle, we always find as its antagonist a large transparent elastic cylinder, without any striæ, and presenting here and there a few brilliant nuclei. This is perhaps the very elongated prolongation of a very short muscle.

Notwithstanding what has been said, *Cyclopsina castor* always swims with the ventral surface downwards. *Canthocamptus staphylinus* swims with the tail as a continuation of the body, and only elevates it when moving upon the glass plate of the microscope. Natation is effected solely by the antennules, and the pereiopods merely enable the animal to maintain its position in the midst of the liquid. The Copepoda possess a density higher than that of pure water. When recently killed, they fall to the bottom of the liquid at the rate of 5 millims. per second.

The presence of an optic ganglion for each eye is the only new point that I have ascertained with regard to the nervous system. I have reobserved the curious sleep of the Cyclopidæ spoken of by M. Zenker.

When submitted to the discharge of a Leyden jar of 1 litre capacity, these little animals fall to the bottom of the water as if thunderstruck; but, singularly enough, in an hour they recover from this stupefaction, and swim about again with vivacity. There is some analogy between these results and those recently obtained by Dr. Richardson, who saw a pigeon and a toad resist the shock of a spark more than 70 centimetres in length, produced by the colossal induction-coil of the Polytechnic Institution*.

With regard to the digestive apparatus, I observed on the inner surface of the *tunica propria* of the first part of the intestine a layer of enormous, transparent, cylindrical epithelial cells, which probably bear vibratile cilia. I was led to this last supposition by the characteristic rotatory movements undergone by particles of alimentary substances in the intestine of a *Cyclopsina*. If my observation were confirmed, it would prove that vibratile cilia may exist in the digestive tube of the Articulata (leaving the Rotatoria out of the question).

A series of experiments made simultaneously upon *Cyclops quadricornis* and *Daphnia simus*, with regard to the influence of sea-water upon these animals, gave me the following results. The *Cyclops* dies in sea-water in a few minutes; the

* Le Cosmos, October 23, 1869, p. 443.

Daphnia resists its action scarcely for a quarter of an hour. M. Paul Bert ascribes the death of sea-fish in fresh water to the difference of density, of osmotic power, and of the power of holding oxygen in solution possessed by the two liquids. Now these small Crustacea do not as yet verify this supposition; for they continued living for eight days and more in a solution of sugar of the same density as sea-water. From my investigations it would appear that we must attribute the death of the Cyclopidæ and *Daphniæ* in sea-water to some of the salts which that water holds in solution. By employing them alone and separately, in the proportions in which they exist in the water of the ocean, we find that the chlorides of sodium and magnesium act like true poisons, and that sulphate of magnesia has no action.

It was supposed until very lately that *Cyclops quadricornis* had no heart. Nevertheless a heart exists in it, and is of a pyriform shape, slightly constricted in the middle, with its broadest end in front. The only aperture I have been able to distinguish in it is a venous fissure at the antero-superior part. Whilst the heart of *Cyclopsina castor* is situated under the first thoracic ring, that of *Cyclops quadricornis*, on the contrary, is near the extremity of the sixth cephalic somite. It beats very slowly.

I have entirely passed over the internal reproductive organs, and only attended to the genital apertures, which are less known.

In *Cyclops quadricornis* the female genital orifice opens on the ventral median line, in the furrow which separates the last thoracic from the first abdominal somite. The last thoracic somite forms its upper lip, and is moved by special muscles. Its lower lip belongs to the following segment.

The investigation of the mode of formation of the oviferous sacs has enabled me to ascertain that the elongated secretory organ lodged in the first and second abdominal segments, and opening at the vulva, is not devoted to the secretion of the sacs, but is a seminal receptacle. The true secretory organ of the oviferous sacs consists of two curved glandular cæca situated beneath the skin of the first abdominal somite. Although at first very indistinctly visible, these glands by degrees acquire more distinct outlines. When the female is fecundated, the seminal receptacle, which is enormously swelled, ascends entirely into the first segment of the abdomen, which it fills up, and at the same time pushes upward the glands just mentioned. These glands, the volume of which has increased at least a hundredfold, extend themselves laterally to the epimera. On each side we find an aperture, which has long been known, between the epimeron and the corresponding episternal piece; each of these apertures bears an oviferous sac. The glands can secrete the two sacs in less than ten hours.

In the genera *Cyclopsina* and *Canthocamptus* the female aperture is situated upon the boundary between the first two abdominal segments. The reservoir and the two glands exist as in *Cyclops*; but here the orifices of the glands open at the vulva, which bears directly the single oviferous sac.

The oviferous sacs are secreted by layers one *within* the other; the bottom has only a single layer.

In the male *Cyclops quadricornis* there are not, as has been supposed, two genital apertures at the angles of the last thoracic somite, although two organs producing the spermatophores actually exist there; but there is only a single orifice, in the form of a fissure, at the posterior margin of the first abdominal somite.

Like the Cladocera, the Copepoda propagate with great rapidity. *A priori* one might suspect in them an apparent or actual parthenogenesis; but my experiments show that young animals isolated immediately after hatching never reproduced, nor did females sequestered after their first oviposition ever produce new oviferous sacs and new eggs. Moreover, in a state of nature, the males are sufficiently common to render parthenogenesis quite unnecessary for the preservation of the species.

XLII.—*Note on* Polytrema miniaceum. By Prof. G. J. Allman, F.R.S.

To the Editors of the Annals and Magazine of Natural History.

Gentlemen,

Among the most abundant products of the dredge on the coast of Mentone is a little, red, branched, coral-like body which attaches itself to various objects brought up from moderate depths. It is so conspicuous that it must be familiar to most naturalists who have studied the fauna of the Riviera, and was long ago described by Risso under the name of *Polytrema corallina*; while, as De Blainville has pointed out, it appears to be identical with the *Millepora miniacea* of Linnæus, whose specific name it must therefore receive.

With the exception, however, of some suspicions of its rhizopodous affinities entertained by Gray and by Dujardin, its real nature appears to have been entirely misunderstood, systematic writers having placed it either among the true

Corals or the Polyzoa, until Carpenter, by the examination of dried specimens received from tropical seas, determined its position to be among the Rhizopoda—a determination subsequently adopted by Max Schultze, who, in a detailed memoir, takes a similar view, arrived at from an examination of Mediterranean specimens preserved in spirits.

Having just had ample opportunity of examining it in a living state, I am enabled to confirm in all essential points the views of Carpenter and Schultze. *Polytrema miniaceum* is a true Rhizopod. Its calcareous skeleton forms a multitude of irregularly superimposed chambers, which freely communicate with one another by large orifices; and besides the large passages by which this free communication is maintained, the walls of the chambers are almost everywhere traversed by capillary canals.

In the living state every chamber is filled with a clear colourless protoplasm, so transparent that its presence may be easily overlooked, until, by the action of alcohol or dilute acid, it loses its transparency and becomes obvious. The protoplasm passes freely from chamber to chamber through the wide passages by which the chambers open into one another, while it also sends delicate prolongations into the capillary canals of the walls. I can confirm Max Schultze's observation of the existence of siliceous spicula, resembling those of sponges, in the interior of the chambers; but as in many specimens I could find no trace of them, I can hardly avoid regarding their presence as accidental.

Though there can thus be no doubt of the rhizopodous nature of *Polytrema*, I never succeeded in detecting the emission of pseudopodial extensions of the protoplasm; and the capillary processes which may be traced into the canals of the chamber-walls were never, during prolonged examination of living specimens, projected beyond the surface.

Any contribution to our knowledge of *Polytrema* will probably be deemed of interest, more especially when we regard the apparent affinities of *Polytrema* with *Eozoon*, and the light which the structure of the living Rhizopod seems capable of throwing on the oldest of known organisms.

I remain, Gentlemen,
Yours faithfully,
George J. Allman.

Mentone, Alpes Maritimes.
April 2, 1870.

XLIII.—*On the Occurrence of* Loxomma Allmanni *in the Northumberland Coal-field.* By ALBANY HANCOCK, F.L.S., *and* THOMAS ATTHEY.

A FEW months ago we announced the occurrence in the Coal-shale near Newcastle of a considerable portion of the cranium of *Anthracosaurus*. We have now the pleasure of recording the presence of another large Labyrinthodont Amphibian in the same locality, Mr. Atthey having recently obtained, in the black shale at Newsham, a nearly perfect skull of *Loxomma Allmanni*, Huxley, which we believe to be the first authenticated specimen of this fine Labyrinthodont that has been found in this neighbourhood.

The skull is complete, with the exception of the muzzle, which is entirely wanting; but in other respects it is in an excellent state of preservation. The exposed surface, which is that of the crown, is wholly covered with the honeycomb-like sculpture usual in these animals. The pits and ridges are remarkably regular and deep, though they are occasionally elongated; the ridges are smooth, and have a semigloss,—which two characters, taken together with the colour, a dark brown, give to the whole surface the appearance of carved box-wood.

As presented to view, the contour of the skull is triangular, with the apex truncated and the base or occipital region arched considerably inwards. The apex or muzzle not being present, it is impossible to say how much it was produced when perfect; but, judging from the gentle inclination of the side margins, it would seem to have been much prolonged. The whole of the muzzle is broken away as far backward as the anterior border of the enormous orbits. Across the broken extremity the skull measures about five inches; and the width of the occipital region at the widest part is nine inches; the length, from the broken anterior extremity to a line drawn between the points of the lateral expansions, is eight inches and a half. But if we make allowance for what is wanting of the muzzle, the length of the skull may be estimated as upwards of twelve inches.

The longitudinal centre of the cranium is composed of a comparatively narrow strip of bone, which is apparently made up of the frontals, the prefrontals, the parietals, the postfrontals, the epiotics, and the occipitals; but it is quite impossible to determine the boundaries of these component parts, as the sutures are invisible, notwithstanding the fine condition of the specimen. The anterior portion of this compound strip of bone divides the large oblique orbits, the posterior portion the great lateral expansions which form the sides of the occipital region. In front it is a little expanded laterally, and measures two and a quarter inches across; thence backwards for two and three-quarter inches the sides arch gently inwards, forming the inner anterior boundaries of what may be termed the anterior division of the orbits; and then for an inch and three-quarters further back the sides are more strongly arched in the same direction, forming the inner posterior boundaries of the posterior division of the orbits, there being at the junction of the two divisions of the inner orbital boundary a strong angular projection, emphatically marking off the two parts. At this point the interorbital bone is two inches wide. A little further back, at the narrowest part, it is only an inch and three-eighths wide. The inner boundaries of the orbits appear to be formed by the pre- and post-frontals.

The posterior portion of this central strip reaches from the hinder margin of the orbits to the occiput, the sides being very slightly arched outwards, and continuous with the lateral expansions. This portion of the cranium is two inches and six-eighths wide, and two inches and three-eighths long, measuring from the posterior boundary of the orbit to the point of the epiotic bone, and, rising a little above the general surface, is strongly defined. The occipital margin is slightly arched inwards, and at either side is produced backwards into short horns—the posterior points of the epiotic bones. This division of the central strip of bone is composed of the occipitals, the parietals, a portion of the postfrontals, and the epiotics, though here, as in the anterior division, the boundaries cannot be determined with precision. No parietal foramen can be observed.

The lateral expansions are each three inches wide, and, according to Prof. Huxley, they are composed of the postorbitals, the malars or jugals, the squamosals, and the quadrates. They project backwards quite an inch and a half beyond the central portion of the skull. The hinder margin of each at first bends outwards and backwards from the side of the epiotic bone for about two-thirds of its extent; it then suddenly turns a little forwards and terminates in a short point at the lateral or external angle. From the base of this point the outer or lateral margin advances forwards and outwards, being at first, for about an inch, a little concave; it then bends a little inwards, and runs forwards in a straight line an inch and five-eighths further to the posterior extremity of the maxilla. From this point, which is only slightly indicated, the lateral walls of the skull are continued in a uniformly inclined line to the anterior extremity. The inner part of the posterior margin is formed by a ridge which thickens and enlarges at the point where it turns suddenly forwards, and this thickened part is turned upwards and overlaps a little the upper surface of the skull; thence to the external point or horn the surface is smooth, and has the appearance of being that of a joint. This is apparently the tympanic bone.

The surface-sculpture, however, does not extend so far back as this; it terminates abruptly in a sigmoidal line that reaches from the outer margin of the epiotic bone about midway between its posterior horn and the hinder boundary of the orbit to the base of the outer cornu. At first this line (that is, its inner extremity) arches gracefully forwards, and then sweeps backwards and outwards to its outer termination, as already indicated. Behind this line the bone is depressed and smooth; the space next the epiotic bone is of considerable extent, and has all the appearance of being for muscular attachment: probably the temporal muscles may originate here; for muscles so placed would be conveniently situated to act upon the articular extremity of the mandible.

The posterior outer boundary of the orbit is formed by the postorbital, the limits of which can be partially traced; it is narrow, and extends from the postfrontal to the inner posterior border of the malar; its orbital margin is concave, and is inclined outwards and forwards. The limits of the malar are also pretty well defined; it is wide behind, before quite narrow, not being more than seven-eighths of an inch wide, including the thickness of the posterior extremity of the maxilla, which forms as it were a narrow border to its straight margin. When perfect, this narrow portion of the malar could not be less than two and a half inches long; more than two inches of it still remains, the anterior extremity having been broken away. The orbital boundary of this part is only very slightly concave; it then rather suddenly bends inwards and backwards as it approaches its junction with that of the postorbital, where there is a slight bulging inwards. From this point the posterior margin of the malar is bounded by the postorbital, the squamosal, and the quadrate. At first this boundary passes inwards and backwards, then outwards and backwards, and finally forwards and outwards, reaching the straight external margin of the malar at the posterior point of the maxilla. This enlarged posterior portion is upwards of an inch and a half wide.

The orbits are both imperfect in front, the anterior boundaries having been broken away; but the form, notwithstanding, is determinable throughout. They are very large, measuring upwards of four inches long and one inch and a half wide at the projection of the interorbital bone. Behind this point, which divides it into two parts, an anterior and posterior, the orbit extends obliquely outwards and forwards; and in front of it the anterior division, which is the larger, turns a little inwards and forwards.

The maxillæ extend backwards to within three inches of the external cornua; as much as four and a quarter inches of the posterior portion is present: they are narrow and straight, and border the straight outer margin of the malar, forming the lateral boundaries of the cranium. In the right maxilla there are five teeth—four towards the anterior fractured extremity, and the fifth, of which the stump only remains, is seven-eighths of an inch from the hinder extremity. Three of the anterior ones are perfect: the first is placed a quarter of an inch from the broken end of the jaw, and is about half an inch from the next tooth; the second, third, and fourth are a quarter of an inch apart (the crown of the latter is gone); the fifth is placed an inch and three-quarters further back, the intermediate teeth having probably been removed. The remains of three or four teeth are observed in the left maxilla, placed about the same distance apart as those of the right maxilla.

These teeth are of equal size; the perfect ones measure three-tenths of an inch in length; they are grooved from the base halfway up the crown; the upper portion is compressed in the direction of the long axis of the jaw, and the sides are produced into wide, sharp cutting-margins; the extremities are abruptly pointed.

A large palatine tooth or tusk is seen a little within the fractured extremity of the right maxilla, sinking into the matrix; the exposed portion is three-quarters of an inch in length; it is half an inch wide at the base, and is three-eighths of an inch wide at the upper extremity; it is therefore probable that not half the tooth is seen, and that it cannot have been less than an inch and a half in length.

The under surface of the specimen is partially exposed; but too little is displayed, and that little is too much disturbed, to admit of clear elucidation. Part, however, of the basisphenoid and its lateral processes can be observed, as well as a portion of the palatal bones; also the palato-temporal foramen seems to be in part recognizable.

We have already stated that this fine cranium is the first authenticated evidence of the occurrence of *Loxomma* in the shale of the Northumberland coal-field. Mr. Atthey, however, has had in his cabinet for several years the crushed cranial bones of this Labyrinthodont; but, owing to the confusion of the parts, we were quite unable to determine to which of the known forms to refer them, until the possession of the specimen under discussion cleared up the matter. We can now trace distinctly the presence of the central portion of the cranium, which agrees with that before us in form and surface-sculpture. A portion of a maxilla, with a few teeth attached, as well as considerable remains of the lateral expansions, are likewise determinable.

Having now the advantage afforded by the possession of this almost perfect skull of *Loxomma Allmanni*, we are also enabled confidently to refer to the two magnificent Labyrinthodont skulls exhibited and described, under the name of *Pteroplax brevicornis*, by Mr. James Thomson and Prof. Young, of Glasgow, at the meeting of the British Association held last year at Exeter. On passing through Newcastle on his road homewards, Mr. Thomson kindly gave us an opportunity of inspecting these specimens; and at the time we pronounced them to belong to *Loxomma*—certainly not to *Pteroplax.* We are now in a position to speak on the subject without the least hesitation, in confirmation of our opinion then expressed. That our cranium is that of *Loxomma*, there is not the least doubt; that it agrees with Mr. Thomson's specimens generically, and, we believe, specifically, is equally certain; and that *Pteroplax* is distinct from *Loxomma*, we have the high authority of Prof. Huxley, who has examined our type specimens of the former.

This is quite evident even on a cursory examination of the two forms. But we may take this opportunity to state that *Pteroplax* deviates considerably, in the structure of the cranium, from all known Labyrinthodonts. In the conformation of the head it approaches the Siren. This fact was entirely overlooked by us at the time of the publication of our paper on the subject (Ann. Nat. Hist. ser. 4. vol. i. p. 266), and was not recognized until Prof. Huxley kindly pointed it out to us some time afterwards.

Pteroplax has no posterior lateral expansions like those in *Anthracosaurus* and *Loxomma*, as we thought it would have (the whole, or nearly the whole, of the cranium is figured in plate xv. fig. 1 of the above paper); the maxillæ are also deficient. The long curved horns are undoubtedly the equivalents of the lateral external cornua in *Loxomma*; and the overlying points are the homologues of the inner horns, being in both genera the posterior extremities of epiotic bones.

Shortly before the occurrence of the cranium of *Loxomma* at Newsham, Mr. Atthey obtained from the same locality a series of vertebræ, lying nearly in natural order, with a few ribs scattered among them. We think these also probably belong to *Loxomma*. There are fourteen or fifteen vertebræ; but, unfortunately, little can be made out respecting them except the form and character of the bodies, the processes of which are not determinable, though they seem mixed up with the matrix, which is partly composed of iron-pyrites.

The largest vertebræ are about seven-eighths of an inch wide, and five-eighths of an inch long; they are slightly hollowed at the ends, with the margins a little reflected; there is a minute notochordal foramen in the centre; but this is not always visible; and the sides are hollowed or channelled, but do not exhibit much striation.

The ribs are peculiar in form; they are about five inches long, but we cannot be certain that they are entire; the shaft is three-eighths of an inch wide, and is not much compressed; nor do they exhibit the longitudinal groove so usual in the ribs of these Amphibians. The proximal extremity is exceedingly wide, measuring across seven-eighths of an inch; it is much compressed; but the capitular margin is thick and continues the curve of the shaft; it projects a little beyond the tuberculum, and is divided from it by a very shallow notch; the bifurcation is consequently exceedingly shallow. The tubercular process turns suddenly from the shaft, and, though thin, widens out into a large concave articular surface, much larger than that of the capitulum.

There is, of course, no certainty that these vertebræ and ribs are really those of *Loxomma*; but, from their occurring in the same locality and about the same time as the cranium, we may infer that it and they came from the same part of the seam; hence the probability that they belonged to the same animal; and, moreover, the ribs differ considerably from those of *Anthracosaurus* and *Pteroplax*, the only other large Labyrinthodonts that have yet been found in the Newcastle coalfield.

MISCELLANEOUS.

The Male Prothallium of the Vascular Cryptogamia. By A. Millardet.

Our knowledge of the true nature of the functions of reproduction in plants is much less advanced than that of the functions of nutrition. Every work upon the former subjects therefore possesses great interest, especially if the author, as in the present case, rises to general considerations, and does not confine himself to the more or less minute description of certain organs. From this point of view the title of M. Millardet's memoir is too modest. After describing some new observations on the development of the microspores of the higher Cryptogamia, the author endeavours to take in at one view the whole series of phenomena of reproduction in the higher plants; and he shows how factitious are the old divisions, and how much less marked than was formerly supposed are the differences between one group and another. Without following him precisely in the arguments which he finds in this in favour of the theory of the filiation of types, we confine ourselves to regarding these extremely interesting observations as fresh proofs of the unity of the plan of creation.

In the first part of his memoir M. Millardet investigates the germination of the microspores of the genera *Marsilea*, *Pilularia*, *Isoëtes*, and *Selaginella*. He has ascertained throughout the presence of a more or less developed prothallium—a peculiarity which has escaped all other observers. In the *Marsileæ* and *Pilulariæ* this prothallium is represented physiologically rather than morphologically, if we may so speak. The antheridium, whilst becoming developed in the heart of the microspore, leaves around it a space filled with a mucilaginous liquid charged with nutritive substances. Although no cell is to be found in them, these materials evidently subserve the production of the antheridium, and thus play the part of a true prothallium. In *Isoëtes* and *Selaginella* the prothallium, although morphologically better defined, plays scarcely any physiological part. The contents of the microspore, in fact, divide into two parts, one of which, very much smaller than the other, a true vegetative cell concealed in the apex of the microspore, becomes enveloped by a membrane, and undergoes no subsequent metamorphosis. In the larger part, on the contrary, the antheridium is developed, and this, in the former of these genera, gives origin to four antherozoids only, whilst in the second it produces a much larger number.

As to the antherozoids, the author takes up a position opposed to that of Schacht. He absolutely denies their cellular nature, regards them only as modified protoplasm, and shows that the vesicle which often adheres to them has no physiological importance in the act of fecundation, and, moreover, is very often wanting. According to him, it is nothing but the residue of the protoplasmic mass placed at the centre of the mother cell, and at the expense of which the antherozoid has been developed.

In the second part of his work, M. Millardet, having ascertained the existence of a male prothallium where none was known before his researches, endeavours to bring forward the morphological importance of this fact by sketching rapidly the evolution of the principal types of the higher plants. As it has been expressed by M. Sachs, we understand by alternation of generations, or alternant generations, "the regular succession in the morphological cycle of an individual of several completely different forms, derived from so many profound changes in its mode of development." Resting upon this dinfinition, the author shows successively, in the different groups of the higher Cryptogamia and of the Phanerogamia, the existence of two successive generations—one sexual, the other asexual.

In the Cryptogamia the phenomenon is easily recognized. Some (Equisetaceæ, Ferns, Ophioglosseæ) are *Isosporeæ*—that is to say, only produce a single kind of spores: these in their turn produce a well-developed prothallium, furnished with chlorophyll and with roots, and consequently capable of an independent existence. On the same prothallium, or on two neighbouring ones, antheridia first of all originate; and these, when mature, emit antherozoids; then follow archegonia, generally formed of a central cell to which access is gained by a canal opening outwards. Fecundation effected, the first period is closed; and then commences the asexual generation. The embryo is developed at first in the bosom of the prothallium, but afterwards becomes disengaged from it, and passes through the different phases of its development, which we have nothing to do with here. Finally, this second generation terminates its evolution by the development of the organs of multiplication, or spores, which always originate from a normal or modified leaf.

The other Cryptogamia (Rhizocarpeæ and Lycopodiaceæ) are *Heterosporeæ*—that is to say, provided with two kinds of spores (microspore or androspore, and macrospore or gynospore). Otherwise the history of their development may be very easily referred to the plan which we have just sketched. From the two kinds of spores originate prothallia, which are frequently more or less rudimentary. Each prothallium will produce antherozoids or archegonia according to its origin. When fecundation has taken place, the second generation will commence; the embryo, at first developed in the bosom of the female prothallium, will soon live an independent life, and become a complete plant. The evolution, as in the preceding case, will conclude by the development of the spores or organs of multiplication.

The Gymnosperms form a very natural transition between the Cryptogamia and the Phanerogamia properly so called. No one will have any difficulty in identifying the anthers with the microsporangia and the grains of pollen with the microspores. The cells, from one to three in number, which are always developed in the heart of the anthers, exactly represent the prothallium; the extreme cell, from which the pollen-tube originates, will be the antheridium. At the point where the pollen-tube applies itself to the ovule, it is often possible to distinguish, in its interior, one or more primordial cells representing the last trace of the mother cells of the antherozoids.

The female organ, rather more profoundly modified, is, nevertheless, still easy to recognize. The embryonal sac, or macrospore, does not separate from the plant like the macrospores of the Cryptogamia; the embryo must, in fact, attain a degree of development much higher than in the preceding cases; it is therefore natural that it should remain adherent to the plant, especially if we consider that the prothallium or endosperm is very slightly developed.

At the moment of fecundation, or even a little before this, the endospermic cells (prothallium) fill the embryonal sac, or macrospore. At the upper part of this some of the cells are soon differentiated and become "corpuscles," which will exactly represent the archegonia. It is in their bosom that, when the proper moment arrives, the germinal cells appear, and that fecundation is effected by diffusion, the fecundating material successively traversing the membrane of the pollen-tube and that of the corpuscles.

It is here that the second period, or asexual generation, commences; and this, in the Phanerogamia, tends to acquire much greater importance than the other. In proportion as the organs which take part in the sexual generation are more degraded, those which originate by asexual generation are more numerous and perfect.

We have not the time to follow here the whole development of the embryo. We will only remark that it commences by living at the expense of the endosperm, as the Cryptogamic embryo lives at the expense of the prothallium. The development of the second generation is interrupted by a period of repose or lethargic sleep in the heart of the seed—a fact which by no means weakens the theory. When, the life of the young plant having resumed its course, it has arrived at its perfect form, it closes its biological cycle by the production of organs of multiplication corresponding to the micro- and macrospores—that is to say, the pollen- and embryonal sacs. As in the Cryptogamia, these spores are produced by modified leaves; the fact is proved as regards the stamens, and is probable at least in the case of the ovules.

Lastly, thanks to the relations which unite them with the Gymnosperms, the phenomena of reproduction of the Angiosperms may be reduced to the same general plan. The pollen-grain will still represent the microspore; only there is no longer any trace of prothallium, any more than of the mother cells of the antherozoids. The development is limited to the expansion of the *intine* in the form of a pollen-tube.

In the embryonal sac, or macrospore, no archegonia are developed; the germinal cells originate directly in its midst; but immediately after fecundation it resumes its part, and becomes the seat of the production of the endosperm or prothallium. The appearance of this, here, follows instead of preceding fecundation. The two periods are therefore less clearly limited in the Angiosperms than in other plants. They nevertheless exist; only the second, or asexual, period tends always to predominate over the sexual period, as has been indicated in the case of the Gymnosperms.

Finally the embryo is developed; and the asexual generation, as in the preceding case, is divided by a period of repose in the heart of the seed. At the end of the period of vegetation the plant always closes its biological cycle by the production of organs of multiplication; only here the modifications are more profound, and, instead of reaching only the leaf destined to produce the spores, they affect the whole upper part of the axis, and thus is formed the flower with its different whorls.

Such is the series of arguments upon which the author founds his idea of the unity of the functions of reproduction in plants—an idea, however, which he ascribes to M. Sachs, who put it forward in his 'Lehrbuch der Botanik,' published at Leipzig in 1868. Whatever value we may attach to his conclusions, this memoir of M. Millardet's possesses great interest. It is only to be regretted that the plates, which the author intends publishing hereafter in a scientific periodical, do not accompany the memoir itself.—*Notice of a work published at Strasbourg in* 1869; from *Bibl. Univ.* March 15, 1870, *Bull. Sci.* p. 275.

Morphological Researches on the Mollusca. (First Memoir: *Gasteropods.*) By M. Lacaze-Duthiers.

One of the most difficult types of the Mollusca to reduce to a theoretical plan is undoubtedly that of the Gasteropods. I propose to show that, by taking the relations of the organs and of the nervous system, it is always possible to refer the various forms to a single plan.

Let us reduce the body of the Gasteropod, for the sake of simplicity, to four parts—the *head*, the *foot*, the *visceral mass*, and the *mantle*. If we unroll the body of a species with a turbinated shell, we shall have beneath the head and behind and below the foot a reversed cone containing the viscera*.

The relations of these parts are essentially variable. Thus the head is often separated from the visceral mass by a true neck. As to the mantle, its morphology is difficult.

The study of the embryo of *Ancylus* enables us with ease to recognize this organ from its origin. In fact, upon the embryonic sphere, the head first betrays itself by the formation of the mouth. Soon two disks, bounded by a circular cushion, show themselves, the one near, the other opposite to the mouth: the former is the foot, the latter the mantle. At this moment the *Ancylus* represents the ideal being with the four principal parts.

Starting from this state, we may vary the forms and explain the modifications of the Gasteropod-type. But, in the first place, to have an exact idea of the mantle, let us suppose the embryonal disk from which it is derived eminently elastic and extensible; let us assume, further, a traction exerted upon its centre and directed backwards, and we shall obtain a reversed cone, of which the apex will be the point of application of the force of traction, and the base the part of the body bounded by the circular cushion of the primitive disk. The intestines will penetrate by traction into the cone thus formed; but the foot and the head will remain without. These four parts will be deformed, but their relations will remain constant.

It is then easy to account for some forms which are very different in appearance. For example, in the *Limaces* the foot increases

* To understand this, the animal is supposed to have the head above, the foot in front, and the apex of the spire and the mantle behind and below.

sufficiently below to lodge the viscera, and the mantle forms nothing more than a little disk or buckler; in the *Testacellæ* and the *Bulleæ* the foot follows the neck in its excessive development, and the mantle remains rudimentary at the end of the body; in the *Aplysiæ* the foot and the neck become much developed upward, but the foot still increases sufficiently in its lower part to cover with its two lobes the back and even the mantle, with which it has been erroneously confounded.

The criterion which I propose enables us to determine the homologous parts.

Four groups of nervous ganglia characterize the Mollusca in general and the Gasteropoda in particular: these are, first, the *stomato-gastric*, the *cerebroid*, and the *pedal* ganglia. The fourth group, intermediate between the latter two, always placed a little behind and below the pedal centre, is *unsymmetrical*—that is to say, formed by an uneven number of ganglia, generally five. It characterizes the Gasteropod group, and, except the head, the neck, the foot, and the viscera, it innervates all the organs. The name which would best designate its relations would be that of *branchio-cardio-pallio-genital*; but I shall simply call it the *median* or *inferior centre*. It varies much: sometimes it forms a very small ring, sometimes an extremely long curve which seems to modify and change all the relations. Thus in the *Limnææ*, the *Planorbes*, and the *Ancyli*, although its ganglia are a little disjointed, it is very close to the other centres. Again, in the *Helices*, the *Testacellæ*, the *Limaces*, &c. its five ganglia lie upon the pedal centre, and are united to it in such a manner by a common conjunctive tissue that they have been described as the posterior pedal ganglia.

In the *Aplysiæ*, the *Bulleæ*, all the *Pectinibranchia*, the *Haliotides*, and the *Cyclostomata*, the commissure which unites the inferior ganglia is long and twisted, and the homologous parts are difficult to recognize. Notwithstanding this, the general connexions remain constantly fixed.

With regard to the mantle, the following facts leave no doubt. By numerous dissections of the most different types, I believe I am able to establish that this part of the body is exclusively innervated by the inferior centre, and that henceforward we may define it thus:—*Any fold or cutaneous part of the body of the Gasteropod receiving nerves from the inferior or unsymmetrical centre is either the mantle or a dependence of the mantle.* The forms of the pallial fold may vary infinitely, their connexions never. How, therefore, can we, in *Aplysia*, regard the two large lobes which ascend at the back and at each side upon its back as being dependences of the mantle, when their nerves all come from the pedal ganglia? These lobes are the foot itself, and they serve for swimming.

The dorsal shield of the *Limaces* is the mantle very slightly developed; it receives all its nerves from the inferior centre; and the part which is drawn out along the lower part of the body and contains the viscera, is the foot, for its nerves are derived from the anterior centre. Again, in the *Testacellæ*, it is the upper part of the neck and of the foot which becomes developed and lodges the organs. The connexions of the nerves show the mantle reduced to that inferior part which covers the shell.

These examples suffice to prove the utility of this principle, which will lead us to a single scheme, the true theoretical and ideal archetype of the Gasteropod.—*Comptes Rendus,* December 27, 1869, tome lxix. p. 1344.

A new British Land-Shell. By J. Gwyn Jeffreys, F.R.S.

My correspondent, Mr. Thomas Rogers of Manchester, has added another species to this well-worked department of our fauna. Specimens of a *Zonites* which he has now sent me, collected by him under stones at Marple Wood, in Cheshire, prove to be the *Helix glabra* of Studer, Fér. Prodr. No. 215. *Z. glaber* has a wide range on the Continent, from Normandy (where I have taken it), through France, Savoy, Switzerland, Germany, and Dalmatia, to Epirus in Greece. I also found the same species in 1846 at Grassmere, and in 1857 at Barmouth, but had overlooked it. Mr. Rogers's specimens being alive, I subjoin a description of the animal.

Body dark bluish grey, striped like a zebra on each side in front, and irregularly mottled behind; in one of the specimens the hinder part of the foot is minutely speckled with yellowish-brown dots; two narrow and slight parallel grooves run along the neck from the head to the upper lip of the shell; the surface is more or less wrinkled, and has a few large but indistinct lozenge-shaped markings: *mantle* very thick and dark at the mouth of the shell, over which its edges are folded: *tentacles,* upper pair rather long, and finely granulated; lower pair very short: *eyes* small, placed on the upper part, but not at the tips, of the tentacular bulbs: *respiratory orifice* round, occupying the centre of the pallial fold: *foot* very long and slender; the sole appears as if separated from the upper part of the foot, being defined by a darker line: *slime* thin and nearly transparent. I could not detect any smell of garlic (so peculiar to *Z. alliarius*), although I frequently irritated the animals.

The shell is three times the size of that of its nearest congener, *Z. alliarius,* and is of a reddish-brown or waxy colour; the whorls are re convex or swollen, the lower part of the shell is not so much arched, the mouth is larger, the umbilicus is smaller and narrower, and the colour underneath is sometimes whitish.

27 April, 1870.

On the presence of peculiar Organs belonging to the Branchial Apparatus in the Rays of the Genus Cephaloptera. By M. A. Duméril.

Having ascertained, in a large species (*Cephaloptera Kuhlii*) from the Indian Ocean, which is wanting in the Neapolitan Museum, the presence of the *prebranchial appendages* which Prof. P. Panceri, of Naples, was the first to see in one of the Mediterranean species (*C.*

giorna), I call attention to this anatomical peculiarity, of which he has given a detailed description in a memoir published in conjunction with M. L. de Sanctis.

On examining at the bottom of the mouth the pharyngeal apertures of the branchial chambers, or separating the walls of their external apertures, we see, in front of each of the respiratory surfaces, a very regular series of organs which do not occur in any other fish, whether bony or cartilaginous. I have ascertained that they are wanting in two species belonging to genera nearly allied to *Cephaloptera* (namely *Rhinoptera marginalis* and *Ætobatis narinari*). Thus their presence appears to me, as to M. Panceri, to constitute one of the essential characters of the genus *Cephaloptera*.

These organs are elongated lamellæ, the aspect of which somewhat reminds us of that of the stems of ferns, but with the leaflets turned back towards the branchiæ. Each being formed of a fold of mucous membrane supported by a cartilage, these lamellæ are attached to the anterior surface of the branchial arches, in front of the membranous and vascular folds of the respiratory organs; and it is their position that has suggested the name of *prebranchial appendages*, by which they are designated by the Italian anatomist.

They do not serve for respiration. By means of injections, M. Panceri has ascertained that they receive arterial vessels, like the other organs, and not branches of the branchial artery. According to him, they are destined, on account of the remarkable size of the apertures of the branchial chambers, the orifices of which are much smaller in the other Rays, to retain the water and prevent it from traversing these cavities with a rapidity which would be injurious to the perfect accomplishment of the act of hæmatosis.—*Comptes Rendus*, March 7, 1870, tome lxx. pp. 491, 492.

Observations on the Turning of Fungi.
By M. P. Duchartre.

The author remarks that whilst the researches of modern botanists have accounted for a great number of the vital phenomena of plants, there are still some whose causes remain in obscurity, although the phenomena themselves may be manifested daily to observation. Among these are the phenomena of direction, the tendencies of certain organs to hold themselves always in a particular position, and to return to that position when designedly displaced from it. The favourite hypotheses upon this subject, especially in Germany, tend to give the phenomena a purely mechanical character; but the author contends that such generalizations have been made too hastily, and cites the following curious instance of the growth of a fungus under very peculiar circumstances in support of his opinion.

In a garden at Meudon (Seine-et-Oise) a cask had been placed to serve as a reservoir for watering the garden; it was a cask of 225 litres, having its bottom covered with a thick layer of plaster; it was placed on end, with its lower part sunk about 25 centimetres below the level of the soil, within a sort of tub large enough to leave between the two an annular space open above and 6 or 7 centimetres in width. The plastered bottom of this cask was bordered all round to a height of 8 centimetres, so that a vacant space of the same height was left beneath it. The cask was kept always full of water, and completely exposed to the sun during the long summer days; so that the atmosphere contained in the vacant space beneath it must have been at once hot, moist, and dark; and the layer of plaster itself was a soil placed under favourable conditions in some respects.

At the end of September 1869, the author found upon the lower surface of this layer of plaster more than 500 individuals of a small Agaric belonging to the genus *Coprinus*. They were at various stages of development, about half of them being already mature; these were from 3 to 4 centimetres in height, with a slender cylindrical stem and a moderately convex, delicate hood, varying in diameter from 12 to 15 millims. Their colour was pale, slightly tawny, but the hymenial lamellæ were of a brownish violet tint. The author believes the species to be *Agaricus* (*Coprinus*) *radians*, Desmaz.

The entire group of Agarics occupied about a quarter of the whole circular layer of plaster, the remaining three-quarters being destitute of them. They were all towards the southern part. Springing from the roof of the cavity under the cask, they had grown from above downwards, or in a direction opposite to their natural one; but their stems departed from the vertical by at least 30°, *their direction being towards the north*. Upon this fact the author remarks that it is in opposition to the hypothesis, particularly maintained by Hofmeister and J. Sachs, that the action of gravity has much to do with the direction of the organs of plants: if the little Agarics had yielded to the action of gravity, they would have followed the vertical line, from which they all departed.

The author also calls attention to the difficulty of understanding the cause of the deviation *towards the north*. The Fungi generally bend towards the light, like Phanerogamous plants; and the author records an experiment made by him with *Claviceps purpurea* growing on ergotized wheat, which constantly turned its stem at an angle of about 45°, in order to direct its head towards the light; so that, when it had been moved two or three times, its stem had become entirely sinuous. But this motion could not have influenced the fungi noticed by the author, as no light could penetrate the space in which they grew; and, moreover, they had directed themselves from the south or sunny side towards the obscurity of the north. Their stems, also, were quite rectilinear.

The most remarkable fact noticed by the author is the following. From the exceptional position in which these fungi were developed, their direction was, of course, reversed, and the hoods had their free and naked surface, which is usually superior, turned towards the ground, whilst their hymenial surface, with its lamellæ, was turned upwards. This reversed position was maintained throughout the young state of the plants so long as the hood, then in the form of a thimble, had its hymenial lamellæ closely applied to the upper part of the stem; but as soon as the hood began to spread out and remove its lamellæ from contact with the stem, the latter bent upwards at a distance of about five millims. from its extremity, in such a manner as to elevate the hood and turn the lamellæ downwards. This bending was not a gradual curvature, but an actual elbow, forming a right (or even a slightly acute) angle, having for its sides the two very unequal portions of the stem, both of which were rectilinear. This turning had taken place upon all the individuals, about fifty in number, which had attained the adult state. The author confesses himself unable to suggest any satisfactory explanation of it. It is evident that the erection of the apex of the stem, which turned the hood over, must have been produced by the sudden elongation of the cellular tissue on one side of the stem to a much greater extent than that on the opposite side; but, as the author remarks, this is merely stating the crude fact, not explaining it. He says that if we chose "to employ a word now much in vogue," we might say that the portion of tissue which was active in this erection acquired at the proper moment a *tension* superior to the tissue occupying the opposite side. But this would be merely to substitute a word having a scientific appearance for more commonplace expressions, and it would still remain to be explained how this unilateral excess of elongation, or this "local tension," could have been produced in an organ in which nothing was predisposed for it, and simply because the exceptional position of the fungus had reversed the natural direction of its organs. That this change of direction is not isolated or accidental, has been proved by the author by experiments on some plants of *Claviceps purpurea* grown in a reversed position, which, on approaching maturity, turned up their stalks by describing a curve forming a larger or smaller portion of a circle, after which the extremities bearing the heads continued to grow upwards. This fact, the author thinks, is still more unfavourable to the theory of the influence of gravity upon the direction of growth of Fungi than even the phenomena observed by him in the Agaric; for the *Claviceps* has no hymenial lamellæ to exhibit the hypothetical tendency to yielding to the action of gravity, its head being nearly globular and symmetrical in all its parts.—*Comptes Rendus*, April 11, 1870, tome lxx. pp. 776–782.

Deep-sea Dredging in the Adriatic.

We understand that Prof. Oscar Schmidt of Gratz will publish in June an account of the Sponges of the Atlantic, founded chiefly on the collections made by Mr. Pourtales and the Scandinavian zoologists, and that he will proceed this summer to various parts of the Adriatic to make deep-sea dredgings, in the steamer 'Triest,' of the Imperial Austrian navy.—J. E. Gray.

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XLIV.—*On* Haliphysema ramulosa *(Bowerbank) and the Sponge-spicules of* Polytrema. By H. J. CARTER, F.R.S. &c.

IN the last Number of the 'Annals,' p. 320, I have suggested that Dr. Bowerbank's *Haliphysema ramulosa* might be a branched form of *Squamulina scopula*, and then have submitted the question whether there might not be some connexion between the arborescent form of *Polytrema* and *H. ramulosa*, on account of the presence of sponge-spicules, stated by Dr. Carpenter (Introduct. Study of Foraminifera, p. 236) to apparently radiate from the extremities of the former.

I am now, through the kindness of my friends Dr. J. E. Gray and Dr. Carpenter respectively, enabled to answer these questions definitively.

In the first place, Prof. Oscar Schmidt has transmitted to Dr. Gray, for the British Museum, among many others, two slides bearing respectively specimens of *Haliphysema Tumanowiczii* and *H. ramulosa* (Bowerbank), Florida; and in the spiculiferous character of the extremities they closely resemble *Squamulina scopula*; but, in the absence of the "pedestal," and other points, it is not clear to me that they are identical in species with *S. scopula* and *S. varians* respectively.

Still, that there can be no doubt of the existence of a *dichotomously* branched species of the same kind of organism as *S. scopula*, Prof. Schmidt's mounted specimen testifies. Besides, this able naturalist promises, in a forthcoming notice, which is already printed, certain observations on the subject, showing that neither *Haliphysema Tumanowiczii* nor *H. ramulosa* can be sponges, although Prof. Schmidt is not at present prepared to state exactly what the real nature of these organisms may be.

Thus the branched form of *Haliphysema* (Bowerbank) is definitively shown to be no more a sponge than the simple or unbranched form, and will probably prove hereafter to be nothing more than a branched form of *Squamulina scopula*, as I at first suggested.

Although Prof. Schmidt had introduced the two species, and the figure of *H. Tumanowiczii*, in his excellent work on the Adriatic Sponges, on the authority of Dr. Bowerbank, it is not only fair to observe, but equally significant, that it will *not* be found in Dr. Gray's proposed " Arrangement of Sponges " (Proc. Zool. Soc. May 9, 1867). Dr. Gray doubted its asserted nature.

In the second instance, I have been provided by Dr. Carpenter with specimens of *Polytrema*, both simple and " arborescent," together with portions of the spiculiferous structure accompanying them, chiefly for examination of the latter; and the result of this I have found to be that, although *Polytrema* widely differs from *Squamulina scopula* and *S. varians* in its foraminiferous characters, still the heterogeneous mixture of sponge-spicules which enters more or less into the composition of their tests respectively appears to me to be the same.

While, however, the basis of the test in *S. scopula* and *S. varians* consists of an agglomeration of siliceous sand, that of *Polytrema* consists of calcareous matter secreted by the animal itself; and so far the basis-material of the tests differs; but sponge-spicules are alike present in that of *Polytrema*, as Schultze has already stated (ap. Prof. Allman, last No. of 'Annals,' p. 373), and in that of *Squamulina scopula* &c.

The spicules differ, of course, with the kinds of sponges growing in the locality from which they are supplied; and hence we do not expect to find exactly the same kinds of spicules in the *Haliphysema* from the Gulf of Florida that we find in *Squamulina scopula* of the British coasts; nor do we expect to find the same kinds of spicules in the specimens of *Polytrema* which were brought from the tropics by Mr. Denis Macdonald to Dr. Carpenter.

Thus in specimens of the spiculiferous structure taken from the latter, I have observed the pin-like, spinous, and sinuous spicules of *Cliona northumbrica*, fragments of the heads and shafts of very large trifid spicules of a *Geodia* (?), together with a very preponderating number of the *minute* stellate spicules, and a few large ones like those of *Tethea lyncurium*, a " dichotomo-patento-ternate " spicule of *Dactylocalyx Bowerbankii*, just like that figured in plate 2. fig. 53 of Bowerbank's 'Brit. Sponges,' and many other kinds, mixed together, but too numerous to mention individually.

In the fragments of spiculiferous structure given me for examination by Dr. Carpenter, the above heterogeneous assemblage is found the minute stellate and smooth pin-like spicules preponderating. On the other hand, in and about some specimens of *Polytrema* on a crab-claw, which Dr. Carpenter also gave me, the preponderating spicule is club-shaped spinous, with anchorate spicules (of the kind mentioned hereafter), with the points, and *not* the heads, of the former projecting outwards—evidencing by this and their preponderance that the sponges which these two combinations respectively represent *grew* on the *Polytrema* accidentally, and not parasitically.

Of course, if *Polytrema* is in the habit of drawing to itself sponge-spicules, which, from the vast number of sponges always growing, dying, and disintegrating at the bottom of the sea, must be almost as plentiful as grains of sand there, it is not strange that the spicules which to-day are matted among its pseudopodia on its surface should, in a few days after, be found in the interior of its calcareous structure; and hence the presence more or less of sponge-spicules throughout the latter may be explained. Moreover, in addition to sponge-spicules, there are frustules of Diatomaceæ, fragments of minute Crustacea, and the minute, clathrous, calcareous bodies of the fleshy parts of Echinodermata,—in short, just as in *Squamulina*, almost any thing and every thing of this kind that may pass in its way. At the same time, the amount of spicules and their variety will vary in the structure of the test of *Polytrema* with the amount of sponges and their variety in the locality in which it may grow; and hence at one time there may be an excess and at another a comparative deficiency of spicules*.

Lastly, as regards the arborescent form of *Polytrema*, compared with Schmidt's *Haliphysema ramulosa* from Florida, the former is massive, extending here and there into short projections which may be termed pseudo-branches, while Schmidt's specimen is slender, dendritic, and *dichotomously* branched three times. For this species Schmidt has proposed, on his slide, the name of "*Lophalia affinis*," instead of "*Haliphysema.*"

It seems also desirable that the spicules preponderating so excessively beyond all others on the specimens of *Polytrema* should be particularized, as they evidently belong to two distinct sponges, hitherto, apparently, undescribed.

That in the fragments taken from Mr. Macdonald's specimens of *Polytrema* by Dr. Carpenter presents a combination

* See also Gray on *Polytrema* in Proc. Zool. Soc. 1858, p. 270, and Ann. & Mag. Nat. Hist. 1858, vol. ii. p. 386; Max Schultze, Ann. & Mag. Nat. Hist. 1863, vol. xii. p. 409, and Gray, *ibid.* 1864, vol. xiii. p. 111.

of smooth pin-like spicules with ovate heads, mixed up plentifully with a mass of minute stellate spicules, each consisting of a globular body more or less covered with a variable number of radiating spines chiefly spinulous at the extremities, together with a few larger ones with smooth conical spines like that figured by Dr. Bowerbank (Brit. Sponges, vol. i. pl. vi. fig. 164) from "*Tethea Ingalli*, MS.," but not the same. This combination, together with the cartilaginous nature of the fragments, indicates a close alliance to *Tethea lyncurium*.

That of the other kind, which grows in a film over the specimens of *Polytrema* on the crab-claw, presents the following combination, viz. :—1, a club-shaped, thickly spinous spicule with the spines recurved or inclined towards the head; 2, a much longer, thin, smooth, cylindrical spicule, with abruptly pointed ends, one of which is occasionally oblong-capitate; and, 3, an anchorate spicule, tridentate, webbed, and "angulated," like that figured by Dr. Bowerbank (Brit. Spong. pl. vi. f. 143) as characteristic of *Spongia plumosa*, Montagu. This, again, is evidently one of Dr. Gray's Esperiadæ (*op. et loc. cit.*).

XLV.—*Notes on a Collection of Spiders made in Sicily in the Spring of* 1868. By E. Perceval Wright, M.D., F.L.S., Professor of Botany, Trinity College, Dublin. *With a List of the Species, and Descriptions of some new Species and of a new Genus*, by John Blackwall, F.L.S.

[Plate VIII.]

Crossing Mont Cenis on the last day of April 1868, I arrived in Florence on the evening of the 1st of May, and, proceeding *viâ* Lucca, Leghorn, and Rome, reached Naples about the 10th of May. Here I joined my kind friend A. H. Haliday, A.M., who had invited me to join him in a month's ramble upon the slopes of Etna. We had to wait until the 15th for Florio's steamer to Messina; but, the weather being very fine, the time was passed by us most pleasantly in wandering, now on the sides of Vesuvius (which at the time was in full eruption, belching forth steam mingled with stones, and ejecting more than one stream of brightly glowing lava), and again by the Lucrine Lake and at Baiæ. Arriving in Sicily, we spent one week collecting at and in the immediate neighbourhood of Messina, and a little more than a fortnight on the slopes of Etna. Catania was our headquarters; but a week was spent at Nicolosi, and it was here that the collection of spiders which is described in the following pages by my friend Mr. Blackwall was made. Mr. Blackwall had already named for me a collection of spiders made at his request in the olive- and vineyards about San Concordio, near Lucca; and I thought it would be a matter of interest to find out what resemblance there might be between the Araneid faunæ of two places so distant from each other, and so unlike in their geological formation—the one consisting chiefly of limestone, the other of volcanic débris. My chief collecting-ground was in the immediate neighbourhood of Nicolosi, at an elevation of about 3000 feet. The inner slopes of the extinct craters of Monti Rossi and the Val del Bove also furnished good collecting-ground. No species were met with out of the woody region. I was obliged to place the collection of spiders in the same bottle with a collection of Coleoptera; and this, unfortunately, got broken on the way to Malta; so that several specimens were destroyed, and many of those saved were partly spoiled. Mr. Blackwall made out twenty-seven species, of which seven appear to him new, and one forms the type of a new genus.

Sphasus italicus, Walck., was as common here as at Lucca. *Salticus intentus*, Blackw., described as new from specimens taken at Lucca, and *S. nitens*, also a Lucca species, were not uncommon. *Thomisus amœnus*, Blackw., was also originally described from a Lucca specimen. The following species were found in Sicily and not at Lucca:—*Lycosa agretyca*, Walck., *L. andrenivora*, Walck., *L. albocincta*, n. sp., *Salticus petilus*, n. sp., *Thomisus diversus*, n. sp., *Philodromus lepidus*, n. sp., *Clubiona erratica*, Walck., *Eresus Walckenaerius*, Walck., *Theridion parvulum*, n. sp. (the absence of species of this genus was remarkable), *Ctenophora monticola*, gen. et sp. nov., *Linyphia polita*, n. sp., *Epeïra apoclisa*, Walck., *E. cucurbitina*, Walck.

I cannot conclude these brief notes on the locality in which these spiders were collected without thanking Mr. Blackwall for the kindness he has ever shown to me and for the great assistance he has always given to me in naming the spiders which I have from time to time (since 1853) collected. The collection of Araneidæ made in the Seychelles is at present under examination by Mr. Blackwall, and contains, he informs me, many very interesting forms, most of them quite giants when compared even with the largest European species.

List and Descriptions of Species. By John Blackwall, F.L.S.

Tribe **Octonoculina.**

Family Lycosidæ.

Genus Lycosa, Latr.

Lycosa agretyca.

Lycosa agretyca, Walck., Hist. Nat. des Insect. Apt. tom. i. p. 308; Blackw., Spiders of Great Britain and Ireland, p. 17, pl. 1. fig. 2.
—— *ruricola*, Latr., Gen. Crust. et Insect. tom. i. p. 120; Sund., Vet. Akad. Handl. 1832, p. 192.
Trochosa trabalis, Koch, Die Arachn. Band xiv. p. 141, tab. 492. figs. 1371–1374.

Lycosa andrenivora.

Lycosa andrenivora, Walck., Hist. Nat. des Insect. Apt. tom. i. p. 315; Blackw., Spiders of Great Britain and Ireland, p. 20, pl. 1. fig. 4.

Lycosa albocincta, n. sp. Pl. VIII. fig. 1.

Length of the male $\frac{3}{10}$ of an inch; length of the cephalothorax $\frac{1}{6}$, breadth $\frac{1}{8}$; breadth of the abdomen $\frac{1}{10}$; length of a posterior leg $\frac{1}{2}$; length of a leg of the third pair $\frac{2}{5}$.

The eyes, which are unequal in size, are disposed in front and on the sides of the anterior part of the cephalothorax; four, much smaller than the rest, form a transverse row immediately above the frontal margin, the two intermediate ones being rather larger than the lateral ones of the same row; the other four describe a trapezoid, the two anterior ones, which are the largest of the eight, forming its shortest side. The cephalothorax is long, compressed before, depressed and rounded on the sides and at the base, sparingly clothed with hairs, and of a dark-brown colour, with a broad yellowish-grey band extending along the middle, and narrow white lateral margins. The falces are long, powerful, subconical, and vertical; the maxillæ are straight, and increase in breadth from the base to the extremity, which is rounded; the lip is somewhat quadrate, being rather broader at the base than at the apex. These parts have a reddish-brown colour, the maxillæ and apex of the lip being much the palest. The sternum has a short oval form; it is convex, glossy, provided with long, upright, black hairs, which are most numerous on its sides, and has a very dark-brown hue. The legs are long, provided with hairs and sessile spines, and are of a red-brown colour, the femora being much the darkest; the fourth pair is the longest, then the
is of a dark-brown colour, and there are several obscure pale-

first, and the third pair is the shortest; each tarsus is terminated by three claws; the two superior ones are curved and pectinated, and the small inferior one is inflected near its base. The palpi resemble the legs in colour; the radial is stronger than the cubital joint, and the digital joint, which is of an oblong-oval form pointed at the extremity, and of a dark-brown hue, is convex and hairy externally, concave within, comprising the palpal organs, which are highly developed, prominent, complex in structure, and of a dark and a light red-brown colours intermixed. The abdomen is oviform, clothed with adpressed hairs, convex above, and projects over the base of the cephalothorax; it is of a very dark-brown hue, and is encompassed by a broad band of white hairs; a similar band, extending along the middle of the upper part, comprises a dark-brown fusiform mark; two oval white spots, placed transversely, occur on the under part, immediately below the branchial opercula.

Genus Sphasus, Walck.

Sphasus italicus.

Sphasus italicus, Walck., Hist. Nat. des Insect. Apt. tom. i. p. 374; Blackw., Journal of the Linnean Society, Zoology, vol. x. p. 409.
—— *gentilis*, Koch, Die Arachn. Band v. p. 97, tab. 170. fig. 404.

Family Salticidæ.

Genus Salticus, Latr.

Salticus intentus.

Salticus intentus, Blackw., Journal of the Linnean Society, Zoology, vol. x. p. 413, tab. 15. fig. 5.

Salticus petilus, n. sp. Pl. VIII. fig. 2.

Length of the male $\frac{3}{10}$ of an inch; length of the cephalothorax $\frac{1}{8}$, breadth $\frac{1}{10}$; breadth of the abdomen $\frac{1}{12}$; length of an anterior leg $\frac{7}{20}$; length of a leg of the third pair $\frac{1}{4}$.

The minute intermediate eye of each lateral row is nearly equidistant from the eyes constituting its extremities. The cephalothorax is long and somewhat quadrilateral, with a shallow depression behind the posterior pair of eyes; it slopes abruptly downwards at the base, projects a little beyond the falces in front, is clothed with short yellowish hairs, and is of a dark-brown colour. The falces are small, subconical, and armed with a few teeth on the inner surface; the maxillæ are enlarged and somewhat divergent at the extremity; and the lip and sternum are oval. These parts are of a dark-brown colour, the extremity of the maxillæ and the apex of the lip having a tinge of red. The legs are hairy and robust, especially those of the first pair, which are provided with a few spines on the inferior surface of the metatarsi and tarsi; they are of a dark-brown hue tinged with red, the tibiæ, metatarsi, and tarsi of the second, third, and fourth pairs being much the palest; the first pair is the longest, then the fourth, and the second and third pairs, which are the shortest, are nearly equal in length; each tarsus is terminated by two curved claws, below which there is a small scopula. The palpi are long and resemble the legs in colour; the humeral joint is curved downwards; the radial is much smaller than the cubital joint, and projects an obtuse apophysis from its extremity on the outer side, which is directed forwards; the digital joint has a short oval form and brown hue; it is convex and hairy externally, concave within, comprising the palpal organs, which are moderately developed, not very complex in structure, prominent, particularly at the base, and of a brown colour faintly tinged with red. The abdomen is long, subcylindrical, tapering slightly to the spinners, and is clothed with adpressed hairs; it is of a brown colour, the under part being the palest, and has a large spot of a dull-yellowish hue above the coccyx.

Salticus nitens.

Salticus nitens, Blackw., Journ. Linn. Soc., Zoology, vol. x. p. 415.
Heliophanus nitens, Koch, Die Arachn. Band xiv. p. 63, tab. 477. fig. 1319.

Family THOMISIDÆ.

Genus THOMISUS, Walck.

Thomisus diversus, n. sp. Pl. VIII. fig. 3.

Length of the female $\frac{1}{4}$ of an inch; length of the cephalothorax $\frac{1}{10}$, breadth $\frac{1}{10}$; breadth of the abdomen $\frac{3}{20}$; length of a leg of the second pair $\frac{7}{24}$; length of a leg of the third pair $\frac{1}{6}$.

The cephalothorax is slightly compressed before, truncated in front, rounded on the sides, abruptly depressed at the base, moderately convex, glossy, with a few black bristles distributed over its surface, and a row directed forwards from its anterior margin; it is of a dark-brown colour mottled with yellowish-white; a whitish line passes transversely between the two rows of eyes, and a broad yellowish-white band, whose anterior extremity comprises several longitudinal brown streaks, extends along the middle; it becomes contracted at the commencement of the posterior slope, and then gradually increases in breadth to the base. The eyes are disposed on the anterior part of the cephalothorax in two transverse curved rows forming a crescent whose convexity is directed forwards; the four intermediate eyes describe a square; and the eyes of each lateral pair are seated obliquely on a tubercle, the anterior ones being the largest of the eight. The falces are short, strong, cuneiform, and vertical; the maxillæ are convex near the base, pointed at the extremity, and inclined towards the lip; and the sternum is heart-shaped. These parts are of a yellowish-white colour, the base of the falces, in front, and the base and sides of the maxillæ being tinged with brown; the sides of the sternum are marked with black spots, and a short streak of the same hue is directed forwards from its posterior extremity. The lip is triangular, and has a dark-brown hue, the median line and apex being the palest. The legs are provided with hairs and spines, two parallel rows of the latter occurring on the inferior surface of the tibiæ and metatarsi of the first and second pairs, which are much longer and more robust than the third and fourth pairs; the second pair slightly surpasses the first, and the third pair is the shortest; each tarsus is terminated by two curved, pectinated claws; these limbs have a dull-yellowish hue freckled with black on the femora and tibiæ; the third and fourth pairs are the palest, and are marked with a few conspicuous black spots on the upper part and sides. The palpi are short, and have a small curved claw at their extremity; they resemble the legs in colour, but are without black marks. The abdomen is somewhat oviform, broader at the posterior than at the anterior extremity, moderately convex above, and projects a little over the base of the cephalothorax; the sides are corrugated; and the upper part, on which a few upright black bristles are distributed, has a strongly dentated band extending along the middle about two-thirds of its length; it is bordered laterally by an irregular brownish-black band, and terminated by a slightly curved, transverse, black bar, whose convexity is directed forwards; the dentated median band comprises five small, pale-brown, circular depressions; the three anterior ones form an angle whose vertex is directed forwards, and the other two are situated parallel to its base; its colour, and that of the upper part of the sides and a space above the coccyx, is yellowish white, but in aged individuals dull yellow; the lower region of the sides and the under part have a rather darker hue, being freckled with black: the sexual organs are small, with a septum in the middle, and of a red-brown colour, that of the branchial opercula being brown.

Thomisus rotundatus.

Thomisus rotundatus, Walck., Hist. Nat. des Insect. Apt. tom. i. p. 500; Blackw., Journ. of the Linn. Soc., Zoology, vol. x. p. 415.
—— *globosus*, Hahn, Die Arachn. Band i. p. 34, tab. 9. fig. 28.

Thomisus citreus.

Thomisus citreus, Walck., Hist. Nat. des Insect. Apt. tom. i. p. 526; Latr., Gen. Crust. et Insect. tom. i. p. 111; Hahn, Die Arachn. Band i. p. 42, tab. 2. fig. 32; Sund., Vet. Akad. Handl. 1832, p. 219; Blackw., Spiders of Great Britain and Ireland, p. 88, pl. 4. fig. 53.
—— *dauci*, Hahn, Die Arachn. Band i. p. 33, tab. 9. fig. 27.
—— *calycinus*, Koch, Die Arachn. Band iv. p. 53, tab. 124. figs. 283, 284.

Thomisus amœnus.

Thomisus amœnus, Blackw., Journal of the Linnean Soc., Zoology, vol. x. p. 415, tab. 16. fig. 7.

Thomisus hirtus.

Thomisus hirtus, Koch, Die Arachn. Band iv. p. 42, tab. 120. figs. 275, 276; Blackw., Journal of the Linn. Soc., Zoology, vol. x. p. 420.

Thomisus abbreviatus.

Thomisus abbreviatus, Walck., Hist. Nat. des Insect. Apt. tom. i. p. 516; Blackw., Spiders of Gt. Britain and Ireland, p. 90, pl. 4. fig. 54; Blackw., Journ. of the Linn. Soc., Zoology, vol. x. p. 420.
—— *diadema*, Hahn, Die Arachn. Band i. p. 49, tab. 13. fig. 37; Koch, Die Arachn. Band iv. p. 51, tab. 123. figs. 281, 282.

Genus Philodromus, Walck.

Philodromus lepidus, n. sp. Pl. VIII. fig. 4.

Length of the female $\frac{1}{5}$ of an inch; length of the cephalothorax $\frac{1}{12}$, breadth $\frac{1}{16}$; breadth of the abdomen $\frac{1}{10}$; length of a leg of the second pair $\frac{3}{8}$; length of a leg of the third pair $\frac{1}{4}$.

The eyes, which are black, are disposed on the anterior part of the cephalothorax in two curved transverse rows forming a crescent whose convexity is directed forwards; the posterior row is much the longer, and the intermediate eyes of the anterior row are rather the largest of the eight. The cephalothorax is short, broad, compressed before, truncated in front, and has a small pointed process at each extremity of its frontal margin; it is rounded on the sides, somewhat depressed, hairy, and of a yellowish-white colour; a dark-brown band extends along each side, above the lateral margin, to its base; and there is a pale-brown streak below the lateral eyes. The falces are subconical, somewhat inclined towards the sternum, and have a brownish-yellow hue. The maxillæ are short, convex near the base, obliquely truncated at the extremity, on the outer side, and strongly inclined towards the lip, which is somewhat quadrate, being broader at the base than at the apex; and the sternum is heart-shaped. These parts have a yellowish-white hue; the base of the maxillæ and of the lip brown spots on the lateral margins of the sternum. The legs are long, provided with hairs and spines, and of a brownish-yellow colour, with pale-brown annuli; the second pair is the longest, then the first, and the third pair is the shortest; each tarsus is terminated by two curved, minutely pectinated claws, and has a scopula on its inferior surface. The palpi resemble the legs in colour. The abdomen is oviform, broadest in the middle, pointed at the spinners, clothed with short, adpressed, yellowish hairs, convex above, and projects a little over the base of the cephalothorax; it is of a yellowish-white colour; a dark-brown fusiform band extends from the anterior extremity along the middle of the upper part nearly half of its length, from a slightly projecting point on each side of which a brown line, enlarged at its extremity, passes obliquely backwards and downwards; to this band succeed several curved dark-brown lines, which rapidly decrease in length, are somewhat enlarged at their extremities, and are followed by a line of the same hue, which terminates in a point at the coccyx; there are a few irregular dark-brown spots on the sides; and a streak of a paler brown passes obliquely upwards and outwards from each side of the coccyx. The sexual organs are moderately developed, with a small, pale, triangular process directed backwards from their anterior margin, and are of a reddish-brown colour, that of the branchial opercula being pale brown, with the exception of the inner margin, which is whitish.

Family Drassidæ.

Genus Clubiona, Latr.

Clubiona erratica.

Clubiona erratica, Walck., Hist. Nat. des Insect. Apt. tom. i. p. 602
Blackw., Spiders of Gt. Britain and Ireland, p. 135, pl. 8. fig. 86.
Bolyphantes equestris, Koch, Uebers. des Arachn. Syst. erstes Heft, p. 9.
Cheiracanthium carnifex, Koch, Die Arachn. Band vi. p. 14, tab. 184. figs. 438, 439.

Family Ciniflonidæ.

Genus Eresus, Walck.

Eresus Walckenaerius.

Eresus Walckenaerius, Walck., Hist. Nat. des Insect. Apt. tom. i. p. 398.
—— *ctenizoides*, Koch, Die Arachn. Band iii. p. 19, tab. 80. fig. 176.
—— *luridus*, Koch, Die Arachn. Band iii. p. 20, tab. 80. fig. 177.

The only specimen of this species contained in the collection was an immature female.

Family THERIDIIDÆ.

Genus THERIDION, Walck.

Theridion pulchellum.

Theridion pulchellum, Walck., Hist. Nat. des Insect. Apt. tom. ii. p. 311; Blackw., Spiders of Gt. Britain & Ireland, p. 191, pl. 14. fig. 122.
Theridium vittatum, Koch, Die Arachn. Band iii. p. 65, tab. 94. fig. 217; Koch, Die Arachn. Band iv. p. 118, tab. 141. fig. 326.

Theridion parvulum, n. sp. Pl. VIII. fig. 5.

Length of the male $\frac{1}{12}$ of an inch; length of the cephalothorax $\frac{1}{24}$, breadth $\frac{1}{24}$; breadth of the abdomen $\frac{1}{24}$; length of an anterior leg $\frac{1}{6}$; length of a leg of the third pair $\frac{1}{12}$.

The abdomen is oviform, convex above, projects over the base of the cephalothorax, and is of a yellowish-white colour; a large, dentated, black band, that tapers to the spinners, and is mottled anteriorly with white, extends along the middle of the upper part; on the under part there is a black spot immediately before the spinners; and a bar of the same hue passes transversely behind the branchial opercula, which are of a dark-brown colour. The cephalothorax is oval, convex, glossy, with a small black indentation in the median line of the posterior region, and is of a pale-brown colour. The eyes are disposed on the anterior part of the cephalothorax in two transverse rows; the four intermediate ones form a square, the two anterior ones, which are seated on a protuberance, being the largest and darkest-coloured of the eight; the eyes of each lateral pair are placed obliquely on a minute tubercle, and are contiguous. The falces are small, conical, and vertical; the maxillæ are obliquely truncated at the extremity, on the outer side, and inclined towards the lip, which is triangular; and the sternum is heart-shaped and glossy; the legs are slender; the first pair is the longest, then the fourth, and the third pair is the shortest; each tarsus is terminated by three claws; the two superior ones are curved and pectinated, and the inferior one is inflected near its base. These parts are of a brownish-yellow colour, the base of the lip being the darkest, and the legs the palest. The palpi are short, and resemble the legs in colour; the radial is smaller than the cubital joint, and is somewhat produced on the outer side; the digital joint is oval, convex and hairy externally, concave within, comprising the palpal organs, which are highly developed and complex in structure; they are encircled by a black filiform spine, and have a yellowish-brown hue. The convex sides of the digital joints are directed towards each other.

Family Ctenophoridæ.

Two spiders, belonging to the genera *Ctenophora* and *Galena*, at present constitute the family *Ctenophoridæ*; they are especially characterized by a conspicuous comb-like appendage, consisting of a series of curved spines of various lengths symmetrically arranged, which is situated on the anterior side of each tibia and metatarsus of the first and second pairs of legs. One of these spiders is indigenous to Sicily, and the other to Rio Janeiro; but their habits and economy have not yet been ascertained.

Genus Ctenophora, Blackw.

Eyes disposed on the anterior part of the cephalothorax in two transverse rows; the four intermediate ones nearly form a square, the two anterior ones, which are seated on a protuberance and are wider apart than the posterior ones, being the largest of the eight; the eyes of each lateral pair are placed obliquely on a small tubercle, and are contiguous.

Falces long, powerful, vertical, united at the base, and armed with a short curved fang and a few small teeth at the extremity.

Maxillæ slender, pointed at the extremity, and strongly inclined towards the lip.

Lip semicircular.

Legs very long and slender, especially those of the first and second pairs, and provided with spines; on the anterior side of the tibiæ and metatarsi of the first and second pairs there is a series of long, prominent, slightly curved spines; and in each of the wide intervals by which they are separated a row of shorter curved spines is situated, which gradually increase in length as they extend down the joints; the first pair of legs is much the longest, then the second, and the third pair is the shortest.

Ctenophora monticola, n. sp. Pl. VIII. fig. 6.

Length of the female $\frac{1}{5}$ of an inch; length of the cephalothorax $\frac{1}{10}$, breadth $\frac{1}{12}$; breadth of the abdomen $\frac{1}{10}$; length of an anterior leg $\frac{5}{8}$; length of a leg of the third pair $\frac{1}{4}$.

The legs have a brownish-yellow hue, and are marked with soot-coloured spots and annuli; each tarsus is terminated by three claws; the two superior ones are curved and pectinated, and the inferior one is inflected near its base. The palpi are slender, rather paler than the legs, with a soot-coloured spot at the base of the radial joint, on the under side, and an annulus of the same hue at the base of the long digital joint, which has a small, curved, pectinated claw at its pointed extremity. The cephalothorax is long, compressed before, rounded on the sides, convex, glossy, depressed at the anterior part and at the base, with an indentation in the median line of the posterior region, and is of a reddish-brown colour; a large vase-shaped mark, bounded by an irregular black line, and projecting from its posterior extremity a small bifid mark of the same hue, which terminates in the median indentation, extends from the eyes along the middle, and comprises some irregular brown lines and yellowish-white spots, a few pale hairs, which spring from prominent, pointed, black bases, being distributed over its surface; there are several black spots on the sides, and a short streak of the same hue on the frontal margin. The falces are of a reddish-brown colour, the extremity being the reddest; they have a few black spots near their base, a large oblong one near the middle of the inner side, and a yet larger one underneath of the same hue. The sternum is heart-shaped, and, with the maxillæ and lip, has a brownish-yellow hue, the base of the lip being much the darkest. The abdomen is short, somewhat oviform, convex above, and projects over the base of the cephalothorax; it has a dull-yellow hue, and is marked with black streaks and spots, which probably describe a regular figure; but in the specimen from which the description was made it was so disfigured that the design formed by the distribution of its colours could not be clearly traced. The sexual organs are well developed, have a narrow black margin, and a brownish-yellow septum in the middle, which is enlarged at its posterior extremity.

The male of this species is at present unknown.

This interesting spider, on which I have founded the genus *Ctenophora*, was captured by Professor E. Perceval Wright on one of the slopes of Etna. By the relative and absolute length of its legs, by the remarkable armature of the first and second pairs, and by the disposition and relative size of its eyes it makes a near approximation to the only species at present known belonging to the genus *Galena* (*Galena zonata*, Koch, Die Arachn. Band xii. p. 105, tab. 419. fig. 1032; Blackw., Ann. & Mag. Nat. Hist. ser. 3. vol. xi. p. 39), which Koch has placed in the family *Epeïridæ*. Both species, by the structure of their maxillæ (and in this particular they present a marked difference) are closely allied to the *Theridiidæ*; and I apprehend that the proper position of the family *Ctenophoridæ*, in which I include them, is intermediate between the *Epeïridæ* and the *Theridiidæ*.

Family Linyphiidæ.

Genus Linyphia, Latr.

Linyphia polita, n. sp. Pl. VIII. fig. 7.

Length of the female $\frac{3}{20}$ of an inch; length of the cephalothorax $\frac{1}{16}$, breadth $\frac{1}{20}$; breadth of the abdomen $\frac{1}{16}$; length of an anterior leg $\frac{1}{3}$; length of a leg of the third pair $\frac{1}{6}$.

The abdomen is oviform, convex above, projects a little over the base of the cephalothorax, and slopes abruptly downwards at its extremity; the upper part is of a pale yellowish-white colour reticulated with brown lines; a black band, which extends from its base along the middle, has its posterior half broken into spots, the largest of which has a triangular form, and is situated at the commencement of the posterior slope; a slightly curved brown band passes along the anterior half of the upper part of each side; and the inferior region of the sides and the entire under part have a brownish-black hue; the sexual organs are well developed, slightly prominent, and of a reddish-brown colour. The eyes are disposed on the anterior part of the cephalothorax in two transverse rows; the four intermediate ones describe a trapezoid whose anterior side is much the shortest, and the two posterior ones are the largest of the eight; the eyes of each lateral pair are seated obliquely on a small tubercle, and are contiguous. The cephalothorax is somewhat compressed before, rounded in front and on the sides, convex, glossy, and of a reddish-brown colour, the sides and base being much the darkest. The falces are long, powerful, conical, vertical, slightly divergent at the extremity, armed with teeth on the inner surface, and a red-brown hue. The maxillæ are straight, the exterior angle at their extremity is curvilinear, and they are of a reddish-yellow colour. The lip is semicircular; and the sternum is heart-shaped. These parts are of a dark-brown colour, the apex of the former and the median line of the latter being the palest. The legs are long, provided with a few fine spines, and are of a dull-yellowish hue; the first pair is the longest, then the second, and the third pair is the shortest; each tarsus is terminated by three claws; the two superior ones are curved and minutely pectinated, and the inferior one is inflected near its base. The palpi, which are slender, resemble the legs in colour, and have a fine slightly curved claw at their extremity.

Family Epeïridæ.

Genus Epeïra, Walck.

Epeïra apoclisa.

Epeïra apoclisa, Walck., Hist. Nat. des Insect. Apt. tom. ii. p. 61; Sund.,

Vet. Akad. Handl. 1832, p. 243; Hahn, Die Arachn. Band ii. p. 30, tab. 48. fig. 116; Blackw., Spiders of Great Britain and Ireland, p. 325, pl. 23. fig. 237.
Epeïra arundinacea, Koch, Uebers. des Arachn. Syst. erstes Heft, p. 2; Koch, Die Arachn. Band xi. p. 109, tab. 385. fig. 913.
Titulus 6, Lister, Hist. Animal. Angl., De Aran. p. 36, tab. 1. fig. 6.

Epeïra solers.

Epeïra solers, Walck., Hist. Nat. des Insect. Apt. tom. ii. p. 41; Blackw., Spiders of Great Britain and Ireland, p. 336, pl. 24. fig. 243.
—— *agalena*, Hahn, Die Arachn. Band ii. p. 29, tab. 47. fig. 115.
Atea sclopetaria, Koch, Uebers. des Arachn. Syst. erstes Heft, p. 4; Koch, Die Arachn. Band xi. p. 134, tab. 390. figs. 934, 935.

Epeïra cucurbitina.

Epeïra cucurbitina, Walck., Hist. Nat. des Insect. Apt. tom. ii. p. 76; Latr. Gen. Crust. et Insect. tom. i. p. 107; Sund., Vet. Akad. Handl. 1832, p. 245; Blackw., Spiders of Great Britain and Ireland, p. 342, pl. 25. fig. 247.
Miranda cucurbitina, Koch, Die Arachn. Band v. p. 53, tab. 159. figs. 371, 372.
Titulus 5, Lister, Hist. Animal. Angl., De Aran. p. 34, tab. 1. fig. 5.

Epeïra adianta.

Epeïra adianta, Walck., Hist. Nat. des Insect. Apt. tom. ii. p. 52; Blackw., Spiders of Great Britain and Ireland, p. 348, pl. 25. fig. 251.
—— *segmentata*, Sund., Vet. Akad. Handl. 1832, p. 247.
Miranda pictilis, Koch, Uebers. des Arachn. Syst. erstes Heft, p. 4; Koch, Die Arachn. Band v. p. 50, tab. 158. fig. 369.

Epeïra antriada.

Epeïra antriada, Walck., Hist. Nat. des Insect. Apt. tom. ii. p. 83; Blackw., Spiders of Great Britain and Ireland, p. 351, pl. 26. fig. [illegible]
Meta muraria, Koch, Die Arachn. Band viii. p. 125, tab. 288. figs. 693, 694.

Epeïra Herii.

Epeïra Herii, Hahn, Die Arachn. Band i. p. 8, tab. 2. fig. 5; Walck., Hist. Nat. des Insect. Apt. ii. p. 89; Blackw., Spiders of Great Britain and Ireland, p. 366, pl. 27. fig. 264.
Singa Herii, Koch, Uebers. des Arachn. Syst. erstes Heft, p. 6.

Genus Tetragnatha, Latr.

Tetragnatha extensa.

Tetragnatha extensa, Walck., Hist. Nat. des Insect. Apt. tom. ii. p. 203; Latr., Gen. Crust. et Insect. tom. i. p. 101; Sund., Vet. Akad. Handl. 1832, p. 256; Hahn, Die Arachn. Band ii. p. 43, tab. 56. fig. 129; Koch, Uebers. des Arachn. Syst. erstes Heft, p. 5; Blackw., Spiders of Great Britain and Ireland, p. 367, pl. 27. fig. 265.
Titulus 3, Lister, Hist. Animal. Angl., De Aran. p. 30, tab. 1. fig. 3.

EXPLANATION OF PLATE VIII.

Fig. 1. *Lycosa albocincta*, ♂ : *a*, palpal organs, left side; *b*, outer aspect of the same; *c*, inner aspect; *d*, sternum in partial profile, to show the long erect hairs on its surface.
Fig. 2. *Salticus petilus*, ♂ : *a*, palpal organs.
Fig. 3. *Thomisus diversus*, ♀ : *a*, cephalothorax; *b*, sexual orifice.
Fig. 4. *Philodromus lepidus*, ♀ : *a*, anterior portion of cephalothorax, represented in a position to show the small pointed process in front of the outer pair of eyes in the anterior row; *b*, sexual orifice.
Fig. 5. *Theridion parvulum*, ♂ : *a*, eyes.
Fig. 6. *Ctenophora monticola*, ♀ : *a*, cephalothorax; *b*, maxillæ and labium; *c*, sexual orifice; *d*, portions of the first and second pairs of legs, more enlarged, to show the rows of spines.
Fig. 7. *Linyphia polita*, ♀ : *a*, eyes.
Fig. 8. Sketch of a left anterior leg of *Galena zonata*, highly magnified, showing the comb-like appendage.

XLVI.—*Notes on some new Genera and Species of Alcyonoid Corals in the British Museum.* By Dr. J. E. Gray, F.R.S., V.P.Z.S., &c.

Busella.

Coral fan-shaped, forming an oblong frond, very much branched and closely reticulated, with a number of short club-shaped branchlets diverging from the sides of the frond; branches and branchlets cylindrical, diverging, furcately branched. Bark thin, granular, smooth. Polype-cells on all sides of the branches and branchlets, sunken, close together, with a small round mouth. Axis continuous, horny, black. (Plexauridæ.)

Busella occatoria = *Rhipidogorgia occatoria*, M.-Edw. & Haime, Corall. i. 179.

Hab. Guadeloupe. B.M.

Muritella.

Coral branched in a plane; stem much compressed, broad; branches and branchlets subcylindrical, apex subclavate. Bark rather thick, granular, with a uniform smooth surface. Polype-cells large, entirely sunken, scattered over the whole surface of the bark, with a very small contracted linear mouth. Axis of the stem and lower branches compressed, horny, of branchlets cylindrical, with a horny external coat, and with soft pith within. (Plexauridæ.)

Muritella fucosa = *Gorgonia palma*, var. *alba*, Esper, t. 11. B.M.
G. albicans, Kölliker.
G. fucosa, Valen. Voy. Vénus, t. 13.

Hab. California. A very variable species.

Boarella.

Coral branched in a plane, fan-shaped, forming an oblong frond with a single stem; branches and branchlets slender, nearly of the same diameter, netted; branches diverging and often inosculating, some of the marginal branchlets free. Bark thin, formed of thin scales or spicules. Polype-cells subcylindrical, elongate, truncate, membranaceous, translucent, with a circular mouth with ten marginal folds and ten short valves in an irregular series on each side of the branches, diverging in different directions, one, sometimes two or three, together. Axis continuous, horny.

Boarella flabellata. B.M.

Menacella.

Coral very much branched, fan-shaped, irregularly reticulated; stem simple. Bark very thin, formed of numerous very slender fusiform spicules in bundles, placed in different directions. Polype-cells short, cylindrical, covered with spicules like the bark, with a smooth, convex, eight-rayed lid, placed close together on the sides of the branchlets, and more scattered and further apart on the sides of the branches. (Muriceadæ.)

Menacella reticularis = *Gorgonia reticularis*, Pallas. B.M.

Phæocella.

Coral branched, fan-like; stem rather compressed; branches irregularly furcate, all in one plane, cylindrical, rarely tapering at the end; branchlets, some subpinnate, others subsecund on the upperside of the branches. Bark thin, formed of abundance of small fusiform opaque spicules placed in groups in different directions. Polype-cells small, on all sides of the stem and branches, ascending, with a rather hood-like outer surface, forming a short cylindrical tubercle, formed of spicules like those of the bark. Axis continuous, horny, black; branches and branchlets tapering. (Muriceadæ.)

Phæocella tuberculata = *Gorgonia tuberculata*, Esper, i. t. 37. Mediterranean.

Bovella.

Coral branched, fan-shaped, expanded into an oblong frond; stem simple; branches and branchlets slender, of the same diameter throughout, branches radiating and irregularly furcately divided, with abundance of short branchlets arranged rather pinnately and diverging at nearly right angles, forming a more or less regular network; many of the branchlets, especially the marginal ones, free. Bark furfuraceous, formed of very small soft spicules or thin scales. Polype-cells circular, prominent, with a sunken centre and a furfuraceous surface, placed on all sides of the branchlets and on the internal surface of the branches. Axis continuous, horny, black.

B. ramulosa, n. sp. B.M.

Menella.

Coral cylindrical, end (of the branches?) clavate, rounded, surface spiculose. Polype-cells on all sides of the cylindrical stem (and branches), close together, forming a rough spiculose surface with hexagonal areolæ. Polypes retractile; when retracted, convex, with an oblong concavity, surrounded with spicules. Axis horny, black.

The only specimen I have seen is simple, cylindrical, and clavate; it is known from all the others by the spiculose surface.

Menella indica.

Coral simple, elongate, cylindrical; end subclavate, white. Axis black.

Hab. Bombay, Back Bay (Captain Thompson). From Mus. Liverpool. B.M.

Rhipidella.

Coral flabellate, netted. Polypes regular, scattered, in small prominent warts. Axis cork-like, with scattered nodules.

Rhipidella verticillata, Solander, Zoophytes, tab. 17.

Gorgonia verticillata, Esper, t. 35.
Rhipidogorgia verticillata, M.-Edw. & Haime, Corall. i. 176.
Suberigorgia verticillata, Kölliker, Icon. Hist. 142, t. 17. f. 9, t. 19. f. 12, 15, 27.

Hab. ——?

Lignella.

Coral branched; stem cylindrical, tapering; branches fan-like, in one plane, angularly diverging. Bark thin, pliable. Polype-cells elongate, prominent, scattered on the stem, and rather far apart on the two sides of the branches. Polypes with eight tentacles. Axis cylindrical, or rather compressed, soft, wood-like, and white, spiculose.

Lignella Richardi.

Bark dark fulvous.

Gorgonia Richardi, Lamx. Pol. flex. 407; Duchass. & Michel. Corall. Antilles, 29, tab. 4. fig. 1.

Hab. West Indies.

LEUCOELLA.

Coral branched, fan-like, in the same plane, compressed; branches furcate, upper side convex or angular, lower side concave, smooth, barren, with a more or less wide central groove. Bark thin and smooth. Polype-cells large and spherical, scattered or in lines on the upper surface and margin of the stem and branches. Axis white, wood-like, soft, with fusiform warty spicules, which are generally slender and elongate, but some are thicker and more ventricose.

Leucoella cervicornis.

Coral irregularly branched; branchlets furcate, crowded. Bark dark brown.

Hab. ——? B.M.

VIOA.

Coral branched, cylindrical, or slightly compressed; branches subacute. Polype-cells occupying the whole surface, sunken. Spicules of the red bark scattered, yellow. Axis placed longitudinally.

Vioa, Nardo, Isis, 1832. Type, *Alcyonium asbestinum*.

Vioa asbestina.

Porus spongioides, Petiver, Gazoph. t. 22. f. 22.
Alcyonium asbestinum, Pallas, Zooph. 344; Esper, ii. tab. 5.
Vioa asbestina, Nardo, Isis, 1832.
Lobularia asbestina, Ehrenb. Coral. 59.
Briareum asbestinum, Verrill.
Briareum suberosum (part.), Kölliker, Icones, p. 141.
Briarea asbestina, Duchass. & Michel. Corall. Antilles, 15.

Hab. West Indies. B.M.

XLVII.—*Notes on the Structure of the* Crinoidea, Cystidea, *and* Blastoidea. By E. Billings, F.G.S., Palæontologist of the Geological Survey of Canada*.

[Continued from p. 266.]

5. *On the Homologies of the Respiratory Organs of the Palæozoic and Recent Echinoderms, and on the "Convoluted Plate" of the* Crinoidea.

In a former note I have advanced the opinion that "The grooves on the ventral disk of *Cyathocrinus*, and also the internal '*convoluted plate*' of the palæozoic Crinoids, with the tubes radiating therefrom, belong to the respiratory and perhaps, in part, to the circulatory systems—not to the digestive system. The convoluted plate, with its thickened border, seems to foreshadow the 'œsophageal circular canal,' with a pendent madreporic apparatus as in the Holothuridea" (*ante*, p. 255, note.) I should have referred it to the madreporic system of the existing Echinodermata in general, instead of to that of the Holothuridea in particular. At the time the note was written I had in view the madreporic sac of *Holothuria*, which, as will be shown further on, most resembles in form that of *Actinocrinus*. The figures and descriptions which follow are intended to show the gradual passage or conversion of the respiratory organs of the Cystidea, Blastoidea, and Palæocrinoidea into the ambulacral canal-system of the recent Echinoderms, and that, as the convoluted plates of the former have the same structure and connexions as the madreporic sacs and tubes or sand-canals of the latter, they are most probably all the homologues of each other.

Among the Cystideans we find several genera, such as *Cryptocrinites*, *Malocystites*, *Trochocystites*, and apparently some others, whose test is totally destitute of respiratory pores, being composed of simple solid plates like those of the ordinary Crinoidea. In a second group of genera, among which may be enumerated *Caryocystites*, *Echinosphærites*, *Palæocystites*, and *Protocystites*, the whole of the external integument seems to have been respiratory, as all or nearly all of the plates of which it is composed are more or less occupied by variously arranged poriferous or tubular structures. The Cystideans of these two groups hold the lowest rank of all those known. In their general structure they are mere sacs, of a globular, ovate, or (as in the case of *Trochocystites*) flattened form. Their test consists of an indefinite number of plates without any radiated arrangement. They were also, according to our present knowledge, the first to make their appearance, two of

* From Silliman's American Journal of Science, January 1870.

Fig. 1.

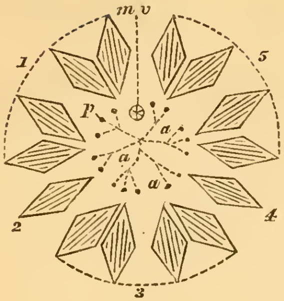


Fig. 2.

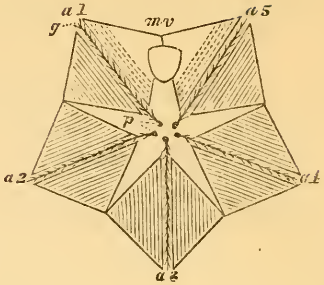


Fig. 3.

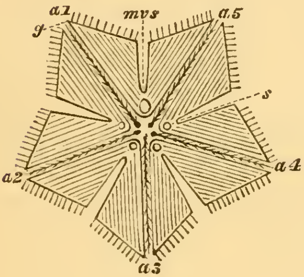


Fig. 4.

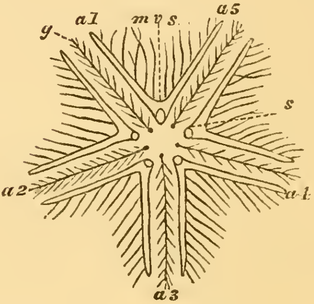


Fig. 5.

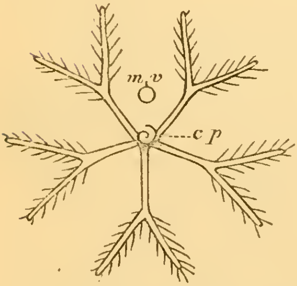


Fig. 6.

Fig. 7.

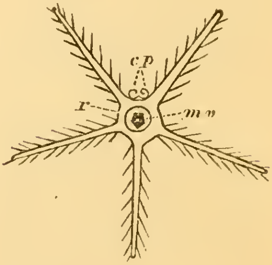


Fig. 1. The upper part of *Caryocrinus ornatus,* the test being removed in order to show the internal structure of the fourteen hydrospires that surround the summit. The parallel lines represent the flat tubes. The other figures exhibit the modifications which the hydrospires undergo in passing through :—fig. 2. *Codaster*; fig. 3. *Pentremites* with broad ambulacra; fig. 4. *Pentremites* with single tubes; fig. 5. Palæozoic Crinoids with a convoluted plate attached to the centre of radiation; fig. 6. Sand-canal or madreporic tube of a starfish, enclosing a doubly convoluted plate; fig. 7. Ambulacral canals of a starfish with the doubly convoluted plate of the sand-canal attached to the œsophageal ring. The following letters have the same reference in all the figures

the genera, *Trochocystites* and *Eocystites*, having been discovered in the primordial zone. No other Echinoderms have been found in rocks of so ancient a date.

Next in order may be placed those genera whose test is composed of a definite number of plates, which have, to some extent, a quinary arrangement. Thus *Glyptocystites*, *Echinoencrinites*, *Apiocystites*, and several others have each four series of calycine plates, of which there are four plates in the basal and five in each of the other three series. The respiratory areas or hydrospires are reduced in number—ten to thirteen in *Glyptocystites*, and three in most of the other genera of the group. Neither in the plates nor in the hydrospires is there exhibited any tendency to a radiated arrangement. The most ancient genus of this family is *Glyptocystites*, which first appears in the Chazy Limestone, and seems to have become extinct in the Trenton. The other genera occur in various horizons between the Chazy and the Devonian.

In the genera *Hemicosmites* and *Caryocrinus* the hydrospires in the upper part of the test converge toward but do not reach the central point of the apex, thus forming the commencement of that concentration and complete radiation which is exhibited in the ambulacral canal-system of the higher Echinoderms. In a former note (*ante*, p. 259) it is pointed out that *Caryocrinus* has thirty hydrospires—ten at the base with their longer diagonals vertical, a zone of six round the middle with their diagonals horizontal, and a third band of fourteen around the upper part of the fossil. These latter are represented in fig. 1 as if spread out on a plane surface. On consulting this figure, it will be seen that the flat tubes of the hydrospires, represented by the parallel lines, all converge toward the central point from which the dotted lines radiate. This point is the position of the mouth in the recent Echinoderms; but in *Caryocrinus* it is occupied by a large solid imperforate plate. The hydrospires are arranged in five groups. Commencing at *m v* and going round by 1, 2, &c., there are four in the first group, one in the second, four in the third, one in the fourth, and four in the fifth. These five groups represent the five ambulacral canals of the recent Echinoderms. In the specimen from which this diagram was constructed there are the bases of fifteen free arms to be seen, situated at the outer extremities of the dotted lines. At the base of each arm there is a small pore (*p*), which I believe to

in which they occur:—*a*, an arm or ambulacrum; *m v*, mouth and vent combined in a single aperture; *m v s*, mouth, vent, and spiracle; *g*, ambulacral groove; *p*, ovarian pore; *s*, spiracle; *cp*, convoluted plate; *r*, œsophageal ring.

have been exclusively ovarian in its function. The hydrospires have no connexion whatever with the arms, and are, moreover, all of them entirely separated from each other. If, then, they represent the ambulacral system of the recent Echinoderms, it is quite certain that that system was at first (or in the undeveloped stage in which it existed in the Cystidea) destitute of the œsophageal ring.

In *Codaster* a further concentration of the respiratory organs is exhibited. There are here only five hydrospires, and they are all confined to the circle around the apex. Two of them are incomplete, in order to make room for the large mouth and vent (*m v*, fig. 2). They are each divided into two halves by an arm *a* 1 *a* 2, &c. They are only connected with the arms to this extent, that these latter lie back upon them. The arms are provided with pinnulæ; but it is not at all certain that the pinnulæ were in any direct communication with the hydrospires. It is evident that *in all the Cystidea* (and in none is it more obvious than in *Caryocrinus*) there was no connexion between the hydrospires and the pinnulæ. The main difference (so far as regards the evidence of the presence or absence of such a connexion) between *Caryocrinus* and *Codaster* consists in this, that in the former the arms are erect and do not touch the hydrospires, whereas in the latter they are recumbent and lie back upon them. Each of the arms of *Codaster* has a fine ambulacral groove; and all of the grooves terminate in a single central aperture. But, as this aperture was covered over by a thin plated integument, as in the Blastoidea, I have not shown it in the diagram, but only the five pores, *p*.

No one who compares a *Codaster* with a *Pentremites* (the internal structure of the latter being visible) can doubt that the hydrospires of the two genera are perfectly homologous organs. If we grind off the test of a species of the latter genus, selecting one for the purpose which has broad petaloid ambulacra, such as those of *P. Schultzii*, the structure exposed will be that represented in the diagram fig. 3. In *Pentremites*, as in *Codaster*, the five hydrospires are divided into ten equal parts by the five rays, *a* 1, *a* 2, &c. In *Codaster* these ten parts remain entirely separate from each other; but in *Pentremites* they are reunited in pairs, the two in each interradial space being so connected at their inner angles that their internal cavities open out to the exterior through a single orifice or spiracle (*s*, figs. 3 & 4). This is best shown in fig. 4, intended to represent the structure of *P. ellipticus* (Sowerby), as described by Mr. Rofe, Geol. Mag. vol. ii. p. 249. In this species the hydrospires, instead of being formed of broad sacs with a number of folds on one side, consist of ten simple cylindrical tubes connected together in five pairs. The only difference between the structure of fig. 3 and fig. 4 is in the width of the tubes and in the absence of folds in the latter. These two forms are, moreover, connected by intermediate grades. Species with eleven, ten, eight, six, five, four, and two folds being known, there is thus established a gradual transition from the broad petaloid form to the single cylindrical tube.

Between the Cystidea and the Blastoidea the most important changes are that in the latter the hydrospires become connected in pairs, and also are brought into direct communication with the pinnulæ. In the palæozoic Crinoidea (or at least in many of them) concentration is carried one step further forward, the five pairs of hydrospires being here all connected together at the centre, as in fig. 5. There is as yet no œsophageal ring (as I understand it), but in its place the convoluted plate described in the excellent papers of Messrs. Meek and Worthen. This organ, according to the authors, consists of a convoluted plate resembling in form the shell of a *Bulla* or *Scaphander*. It is situated within the body of the Crinoid, with its longer axis vertical and the upper end just under the centre of the ventral disk. Its lower extremity approaches, but does not quite touch, the bottom of the visceral cavity. Its walls are composed of minute polygonal plates, or of an extremely delicate network of anastomosing fibres. The five ambulacral canals are attached to the upper extremity, radiate outward to the walls of the cup, and are seen to pass through the ambulacral orifices outward into the grooves of the arms. (Silliman's Journ. vol. xlviii. p. 31.)

The ambulacral canals of the Crinoidea are, for the greater part, respiratory in their function. They are, however, as most naturalists who have studied their structure will admit, truly the homologues of those of the Echinodermata in general. In the higher orders of this class the canals are usually more specialized than they are in the lower, being provided with prehensive or locomotive organs. In all of the existing orders, including the recent Crinoidea, we find an œsophageal ring.

To this organ, which is only a continuation of the canals, are attached the madreporic appendages. These consist of small sacs or slender tubes, varying greatly in form and number in the different genera. That of the starfish *Asteracanthion rubens* is thus described by Prof. E. Forbes:—"On the dorsal surface is seen a wart-like striated body placed laterally between two of the rays: this is the *madreporiform tubercle or* *nucleus.* When the animal is cut open, there is seen a curved calcareous column running obliquely from the tubercle to the plates surrounding the mouth; Dr. Sharpey says it opens by a narrow orifice into the circular vessel. It is connected by a membrane with one side of the animal, and is itself invested with a pretty strong skin, which is covered with vibratile cilia. Its form is that of a plate rolled in at the margins till they meet. It feels gritty, as if full of sand. When we examine it with the microscope, we find it to consist of minute calcareous plates, which are united into plates or joints, so that when the investing membrane is removed, it has the appearance of a jointed column. Professor Ehrenberg remarked the former structure, Dr. Sharpey the latter: they are both right. Both structures may be seen in the column of the common cross-fish." (Forbes, 'British Starfishes,' p. 73.)

In Prof. Joh. Müller's work, 'Ueber den Bau der Echinodermen,' several forms of the madreporic appendages of the different groups of the recent Echinodermata are described. In general they are composed of a soft or moderately hard skin consisting of a minute tissue of calcareous fibres or of small polygonal plates. The walls are also sometimes minutely poriferous. In all the Holothurians the madreporic organ is a sac attached by one of its ends to the œsophageal canal, the other extremity hanging freely down into the perivisceral cavity, not connected with the opposite body-wall, as is the sand-canal of the starfishes (*op. cit.* p. 84). In its consisting of a convoluted plate, the madreporic organ of *Actinocrinus* therefore agrees with that of the starfishes, while in its being only attached at one extremity it resembles that of the Holothurians.

The convoluted plate of the palæozoic Crinoids and the madreporic sacs and tubes (or sand-canals) of the recent Echinoderms, therefore, all agree in the following respects:—

1. They have the same general structure.
2. They are all appendages of the ambulacral system.
3. They are all attached to the same part of the system—that is to say, to the central point from which the canals radiate.

The above seems to me sufficient to make out at least a good *primâ facie* case for the position I have assumed. When among the petrified remains of an extinct animal we find an organ which has the same general form and structure as has one that occurs in an existing species of the same zoological group, we may, with much probability of being correct in our opinion, conclude that the two are homologous, even although we may not be able positively to see how that of the fossil is connected with any other part. But when, as in this instance, we can actually see that it is an appendage of another organ (or system of organs, rather), which is known to be the homologue of the part with which that of the existing species is always correlated, we have evidence of a very high order on which to ground a conclusion. By no other mode of reasoning can we prove that the column of an *Actinocrinus* is the homologue of that of *Pentacrinus caput Medusæ.*

In an important paper entitled "Remarks on the Blastoidea, with Descriptions of New Species," which Messrs. Meek and Worthen have kindly sent me, the authors, in their comments upon my views, state that—

"In regard to the internal convoluted organ seen in so many of the Actinocrinidæ, belonging to the respiratory instead of the digestive system, we would remark that its large size seems to us a strong objection to such a conclusion. In many instances it so nearly fills the whole internal cavity that there would appear to be entirely inadequate space left for an organ like a digestive sac outside of it, while the volutions within would preclude the presence of an independent digestive sac there. In addition to this, the entire absence, so far as we can ascertain, of any analogous internal respiratory organ in the whole range of the recent Echinodermata, including the existing Crinoids, would appear to be against the conclusion that this is such, unless we adopt the conclusion of Dujardin and Hupé, that the palæozoic Crinoids had no internal digestive organs, and were nourished by absorption over the whole surface. We should certainly think it far more probable that this spiral organ is the digestive sac than a part of a respiratory apparatus."

The objection here advanced does not appear to me to be a strong one. In many of the lower animals the digestive organs are of inconsiderable size in proportion to the whole bulk. In the Brachiopoda, for instance, the spiral ciliated arms fill nearly the whole of the internal cavity, the digestive sac being very small and occupying only a limited space near the hinge. These arms, although not the homologues of the convoluted plates of the palæozoic Crinoids, have a strong resemblance to them, and are, moreover, at least to some extent, subservient to respiration. They are certainly not digestive sacs. In the recent Echinoderms the intestine is usually a slender tube with one or more curves between the mouth and the anus. It fills onlya small part of the cavity of the body, the remainder being occupied mostly by the chylaqueous fluid, which is constantly in motion and undergoing aëration through the agency of various organs, such as the respiratory tree and branchial cirri of the Holothuridæ, the dorsal tubuli of the Asteridæ, and the ambulacral systems of canals of the class generally. In no division of the animal kingdom do the respiratory organs occupy a larger proportion of the whole bulk than they do in the Echinodermata. The great size which the convoluted plate attains in some of the Crinoids is therefore rather more in favour of its being a respiratory than a digestive organ.

Professor Wyville Thomson says that, inside of the cavity of the stomach of the recent Crinoid *Antedon rosaceus*, there is a spiral series of glandular folds, which he supposes to be a rudimentary liver (Phil. Trans. R. S. 1865, p. 525). It is barely possible that the convoluted plate may represent this organ. At present I think it does not.

I believe that the reason why the convoluted plate attained a greater proportional size in the palæozoic Crinoids than do the sand-canals of the recent Echinoderms, is that the function of the system of canals (of which they are all appendages) was at first mostly respiratory, whereas in the greater number of the existing groups it is more or less prehensive or locomotive, or both.

[To be continued.]

XLVIII.—*Descriptions of some new Species of Birds from Southern Asia.* By Arthur, Viscount Walden, P.Z.S. &c.

Geocichla layardi, n. sp.

The *Geocichla* of Ceylon is most nearly allied to *G. citrina*, (Lath.), of Northern and Central India, and not, as might have been expected, to *G. cyanota*, (J. & S.), of Malabar. From Latham's bird it is to be readily distinguished by the much deeper orange of the head and nape, these parts being of the same dark shade of orange-brown characteristic of *G. rubecula*, Gould, ex Java. On the under surface the orange tints are brighter and richer than in *citrina*, yet not nearly so dark as in *G. rubecula*; the blue-grey portion of the plumage is likewise darker than in *G. citrina*, but not so dark as in *G. rubecula*. In the distribution of the white plumage the three species resemble each other; they appear, along with *G. rubiginosa*, Müller, ex Timor, to form a small natural section. Wing $4\frac{3}{8}$ inches, bill $\frac{4}{8}$.

Described from a single Ceylon example, and which is marked by the collector as "rare."

Irena turcosa, n. sp.

Irena puella, (Lath.), Horsf. Linn. Tr. xiii. p. 153.

The species belonging to the genus *Irena* may be divided into two sections:—the first consisting of a single species, *I. cyanogastra*, Vigors, from the Philippines; the second comprising, at the least, three closely related species, of which *I. puella*, (Latham), may be made the type. *I. puella* appears to be restricted to the Western Ghauts of India and to Ceylon; for, judging only, it is true, from examples of the female, the Burmese race belongs to that of Malacca; and individuals from Arracan and Assam will, in all probability, be found to agree with those from Burma. The Malayan form, *I. cyanea*, (Begbie), (Malayan peninsula, 1834) = *I. malayensis*, Moore, frequents both the peninsula of Malacca and the island of Sumatra; for between examples from these two localities I can detect no distinction. Java contains a third species, the *I. puella*, (Lath.), ap. Horsf.; and it is for this species I propose the title given above. As in *I. cyanea*, (Begbie), the Javan *Irena* has the upper and under tail-coverts much more developed than in *I. puella* from the Western Ghauts. In my Javan examples the tail-coverts surpass the rectrices in length, while in *I. cyanea* the coverts do not quite equal the rectrices. The bill of *I. turcosa* is also stouter than that of *I. cyanea*. But the Javan *Irena* is most distinguished by the blue colouring of the upper plumage being light turquoise. When compared together, the Malabar *Irena* is dark blue, inclining, in some lights, to purple; the Malayan is of a somewhat lighter shade of blue; the Javan is light blue. In all three species the length of the wing is equal. In the Malabar bird the tail exceeds that of the other two by a quarter of an inch. The females of the Malayan and Javan species closely resemble each other in the colour of their plumage; the female of the Malabar bird is much darker, and easily recognizable.

Latham's *Fairy Roller* (Syn. Suppl. i. p. 87) was described from a drawing by Lady Impey. If the subject of that drawing was from Eastern India or the Malay peninsula (in itself most highly probable), the Malayan species will bear the title of *I. puella*, (Latham), and the Malabar bird that of *I. indica*, A. Hay; but, as the point is seemingly beyond the reach of proof, it will be best to adhere to the titles given above.

Ephialtes jerdoni, n. sp.

Ephialtes lempiji, Horsf., Jerdon, in part, B. of Ind. i. p. 138.

This title is suggested for the larger *Scops* owl of Malabar. Mr. Gurney, to whom I have submitted a large series of *E.*

lempiji, (Horsf.), and its affined species, concurs with me in the propriety of bestowing a separate title on the species inhabiting the Western Ghauts of India. It is chiefly characterized by the ruddy ground-colour of its plumage, and the tarsal feathers being nearly, if not quite, immaculate. This and *Scops griseus*, Jerd., form two well-marked species, both differing from Javan examples of *E. lempiji*, (Horsf.), the first inhabiting the Western Ghauts, the second the Eastern, and also the forests in the vicinity of Maunbhoom.

XLIX.—*On some Species of Proboscidiferous Gasteropods which inhabit the Seas of Japan.* By Arthur Adams, F.L.S., Staff-Surgeon, R.N.

Since I published my paper, in the 'Journal of the Linnean Society' for 1863, on the species of Fusidæ which were found by myself in Japan, I have seen the elaborate work of Dr. Schrenck on the Mollusca of Amur-Land and the Seas of Northern Japan. He there figures a very fine species of *Neptunea*, a group which seems to have its headquarters in northern seas, which he has named *Buccinum pericochlion*, and which is very similar in form to the elegant shell named by Dr. Baird *Chrysodomust abulatus*, from Vancouver's Island. *Buccinum yessoensis*, Schrenck, which I found in Aniwa Bay, in the island of Saghalien, belongs, I believe, to the genus *Urosalpinx*, recently established by Stimpson, as does also *Euthria badia*, A. Ad., from Tsus-Sima. The *Fusus lineolatus*, Dkr. (*Buccinum Dunkeri*, Küst.), is a Cape species of *Cominella*, but is stated by Schrenck to be also found in Hakodadi Bay.

In the 'Annals and Magazine of Natural History' for March 1863, I described twelve species of *Siphonalia*, a Fusoid genus which seems to represent *Neptunea* in the south of Japan. In the 'Proceedings of the Zoological Society' for 1862 the species of Muricidæ found in Japan are enumerated; and in the 'Journal of the Linnean Society,' vol. vii., I have given a list of the species of Mitridæ found by myself in Japanese waters. I now present the results of my personal knowledge of some other families of Proboscidiferous Gasteropods which inhabit the seas of Japan.

Fam. **Tritoniidæ.**

Genus Tritonium, Link.

T. Saulicæ, Rve. (*Triton*), Conch. Icon. Mon. Triton.

Hab. Tatiyama, Tsusaki, Takano-Sima, Bay of Yeddo.

Genus SIMPULUM, Klein.

1. *S. olearium*, Linn. (*Murex*), Syst. Nat. ed. 12.

Murex costatus, Born.
—— *parthenopus*, Dillw.
Triton succinctus, Lamk.
—— *olearius*, Rve. sp. 32.

Hab. Tatiyama.

2. *S. lirostoma*, A. Ad.

S. testa ovato-fusiformi, rufo-fusca; anfractibus 6, convexis, varice unico postice complanato, longitudinaliter plicatis, transversim crenulatis, ad plicas nodulosis et liris duplicis instructis, interstitiis cancellatis; apertura ovata, labio transversim corrugato-plicato, plicis postice et antice validioribus, canali elongato vix recurvo; labro extus fimbriatim varicoso, intus valde lirato, margine crenato.

Hab. Simidsu.

A species of ordinary form, with a strongly lirate aperture and with the transverse ridges and liræ all double.

3. *S. papillosum*, A. Ad.

S. testa acuminato-ovata, alba, punctis rubris ornata, spira acuta, aperturam æquante; anfractibus 6, planis, serie tuberculorum rubrorum circumcinctis ad suturas monile granulorum instructis; anfractu ultimo seriebus tribus granularum quarum duabus anterioribus parvis, lirisque paucis granulosis intermediis, anfractu ultimo varice unico ad latus sinistrum; apertura subcirculari, labio transversim rugoso-plicato, postice tuberculo valido dentiformi instructo, canali mediocri dextrorsum inclinato; labro extus varicoso, intus lævi, postice emarginatione canaliculato instructo.

Hab. Takano-Sima.

A white shell, with red papillose tubercles and rows of necklace-like intermediate liræ.

4. *S. nodiliratum*, A. Ad.

S. testa ovato-fusiformi, alba, spira quam apertura longiore; anfractibus 6, planis, subimbricatis, ad suturas excavatis, longitudinaliter plicatis, plicis liris transversis validis nodulosis decussatis, interstitiis interdum lirula granulosa instructis; apertura ovato-oblonga; labio transversim rugoso-plicato; labro intus nodoso-plicato, extus varice crasso instructo, canali brevi, angusto, vix recurvato.

Hab. Japan. Coll. Cuming.

A small, white, ovate species, with nodosely lirate whorls.

5. *S. tringa*, A. Ad.

S. testa ovato-fusiformi, spira quam apertura longiore, fusca fulvo rufoque variegata, epidermide tenui, pilosa obtecta; anfractibus 8, subdistortis, varicibus paucis irregulariter nodoso-plicatis instructis, in anfractu ultimo quatuor, prope aperturam varice unico duplicato, prope labrum varicibus duobus nodiformibus sulcis longitudinalibus et liris transversis decussatis; apertura ovata; labio circumscripto, transversim lirato, rostro elongato, tenui, rectiusculo; labro intus nodoso-plicato, extus valde varicoso.

Hab. Uraga.

A small species, with the aperture resembling the profile of a plover's head, and with a slender straight beak at the fore part.

Genus Cabestana, Bolt.

1. *C. labiosa*, Wood (*Triton*), Ind. Test. Suppl. pl. 5. f. 18.
Tritonium rutilum, Mke.

Hab. Uraga, 21 fathoms.

2. *C. dorsuosa*, A. Ad.

C. testa ovato-fusiformi, epidermide tenui fusca induta, spira quam apertura longiore; anfractibus 5, varice unico rotundato. nodoso-plicato, plicis in anfractu ultimo antice obsoletis, transversim porcatis, porcis duplicibus, interstitiis liris duabus crenulatis; apertura ovata; labio antice transversim subplicato, canali recto brevi; labro extus varicoso, intus nodoso-lirato.

Hab. Tatiyama.

A fuscous-brown species, strongly nodose on the back of the last whorl.

Genus Gutternium, Klein.

G. moritinctum, Rve. (*Triton*), Conch. Icon. sp. 49.

Hab. Tatiyama.

Genus Epidromus, Klein.

E. reticosus, A. Ad.

E. testa ovato-fusiformi, fulva, hinc et illuc maculis rufescentibus tincta, spira quam apertura longiore; anfractibus 7, convexis, longitudinaliter plicatis, plicis rotundis, distantibus, in anfractu ultimo nodo magno variciformi instructo, transversim valde liratis, liris æqualibus, regularibus, subdistantibus; apertura anguste ovata; labio transversim rugoso-plicato, canali brevi, recto, oblique truncato; labro intus valde lirato, margine extus varice crasso instructo.

Hab. Japan. Coll. Cuming.

A small, reticulate, *Phos*-like species, with regular plicate whorls and a short canal.

Genus Distorsio, Bolt.

D. decipiens, Rve. (*Triton*), Conch. Icon. sp. 102.

Hab. Satanomosaki, 55 fathoms; Okosiri, 35 fathoms.

Genus Bursa, Bolt.

B. subgranosa, Beck (*Ranella*), Sow. Conch. Illustr. *Ranella*, f. 18; Reeve, sp. 1.

Ranella Beckii, Kien.

Hab. Seto-Uchi, Tomo.

Genus Argobuccinum, Klein.

A. olivator, Meusch. (*Murex*), Mart. Conch. vol. iv. pl. 128. f. 1229.

Gyrineum natator, Bolt.
Ranella tuberculata, Brod. & Sow. Proc. Zool. Soc. 1832.

Hab. Tatiyama.

Genus Eupleura, H. & A. Ad..

E. perea, Perry (*Biplex*), Conch. pl. 4. f. 5.

Ranella pulchra, Gray, Sow. Conch. Illustr. *Ranella*, f. 19.

Hab. Kuro-Sima, 52 fathoms.

Fam. **Buccinidæ.**

Subfam. *Buccininæ.*

Genus Buccinum, Linn.

1. *B. glaciale*, Linn. Syst. Nat. ed. 12. p. 1204; Rve. sp. 18.

Tritonium glaciale, Müll.
Buccinum carinatum, Phipps.
—— *angulosum*, Gray, Beech. Voy. pl. 36. f. 6.

Hab. Cape Notoro, Aniwa Bay, Saghalien, Sio-Wuhu.

2. *B. undatum*, Linn. Syst. Nat. ed. 12. p. 1204; Rve. sp. 3.

Buccinum vulgare, Da Costa.
—— *striatum*, Penn.
—— *solutum*, Dillw.
—— *labradorense*, Rve.
—— *pyramidale*, Rve.
—— *pelagicum*, King.
—— *schantaricum*, Schr.

Hab. Aniwa Bay, Gulf of Tartary, Sio-Wuhu.

3. *B. japonicum*, A. Ad. Ann. & Mag. N. H. 1861.

Hab. Okosiri, 35 fathoms.

A small but exquisite species.

4. *B. ochotense*, Midd. Reise in Sibir. t. 10. f. 12, t. 9. f. 5.
Hab. Saghalien (*Schr.*).

Genus Volutharpa, Fischer.

1. *V. ampullacea*, Midd. (*Bullia*), Beitr. zu einer Malac. Rossica, ii. p. 180.

Hab. Aniwa Bay, Saghalien (17 fathoms), Gulf of Tartary (29 fathoms).

2. *V. Perryi*, Jay (*Bullia*), Perry's Exp. to Japan, Appendix.
Hab. Hakodadi Bay.

3. *V. Fischeriana*, A. Ad.

V. testa ovata, tenui, fragili, epidermide fusca, tenui, crebre ciliata induta; spira brevissima, apice subpapillato; anfractu ultimo ventricoso, sutura impressa; apertura ampla, dilatata, intus alba, antice emarginata; labio callo albo lævissimo tenui obtecto; labro margine arcuato, semicirculari.

Long. 1 in., diam. 11 lin.

Hab. Korea Strait, South Japan.

A very neat species from the south of Japan, intermediate in form between *V. ampullacea*, Midd., and *V. Perryi*, Jay. It is a thinner and smaller shell, with a hispid epidermis, the short hairs being arranged in close-set cross rows, giving the surface a reticulated appearance.

Subfam. *Purpurinæ.*

Genus Tribulus, Klein.

1. *T. echinatus*, Blainv. (*Ricinula*), Nouv. Ann. du Mus. pl. 11. f. 2; Reeve, Conch. Icon. (*Purpura*) sp. 33.
ab. Tatiyama, Sado.

2. *T. tumulosus*, Rve. (*Purpura*), Conch. Icon. sp. 55.
Hab. Tsus-Sima, Yeddo Bay (*Lischke*).

3. *T. Bronni*, Dkr. (*Purpura*), Moll. Japan. pl. 1. f. 23.
Hab. Nagasaki, Tatiyama.

Genus Stramonita, Schum.

1. *S. hæmastoma*, Linn. (*Buccinum*), Syst. Nat. ed. 12. p. 1202.
Purpura hæmastoma, Rve. sp. 21.
—— *cornuta*, Mke.
Hab. Hakodadi Bay.

2. *S. luteostoma*, Chem. (*Buccinum*), Conch. Cab. vol. ix. p. 83, pl. 187. f. 1800, 1801.

Purpura luteostoma, Rve. sp. 35.

Hab. Tsus-Sima, Tatiyama (*A. Ad.*); Hakodadi (*Schr.*), Yokohama (*Lischke*).

3. *S. undata*, Lamk. (*Purpura*), Hist. Nat. ed. 2. t. 10, p. 67.

Purpura rustica, Lamk.

Hab. Hakodadi (*Schr.*).

Genus Polytropa, Swains.

1. *P. lapillus*, Linn. (*Buccinum*), Syst. Nat. ed. 12. p. 1202.

Buccinum filosum, Gmel.
Purpura lapillus, Lamk.
—— *imbricata*, Lamk.
—— *bizonalis*, Lamk.
—— *fimbriata*, Lamk.
—— *squamosa*, Lamk.
—— *Freycineti*, Desh.
—— *attenuata*, Rve.?
—— *analoga*, Forbes.

Hab. Cape Notoro, Saghalien, Hakodadi, Rifunsiri.

2. *P. decemcostata*, Midd. (*Purpura*), Beiträge zu einer Malac. Rossica, Taf. 9. f. 1, 2, 3.

P. canaliculata, Ducl.

Hab. Cape Tofuts, Aniwa Bay.

3. *P. crispata*, Chemn. (*Buccinum*), Conch. Cab.

P. septentrionalis, Rve. (*Purpura*), Conch. Icon. sp. 50.
P. plicata, Mart.
P. lactuca, Esch.

Hab. Aniwa Bay, Saghalien, Olga Bay, Vladimir Bay.

Genus Sistrum, Montf.

1. *S. tuberculatum*, Blainv. (*Ricinula*), Nouv. Ann. du Mus. pl. 9. f. 3; Reeve, Conch. Icon. (*Purpura*) sp. 11.

Purpura marginella, Blainv.
—— *granulata*, Ducl.

Hab. Sado, Tsus-Sima, Tatiyama.

2. *S. sidereum*, Rve. (*Ricinula*), Conch. Icon. sp. 14.

Hab. Takano-Sima.

Genus Engina, Gray.

1. *E. acuminata*, Rve. (*Ricinula*), Conch. Icon. sp. 52.

Hab. Tsus-Sima.

2. *E. concinna*, Rve. (*Ricinula*), Conch. Icon. sp. 35.
Cantharus Menkeanus, Dkr. Moll. Japon. pl. 1. f. 7.
Hab. Kino-O-Sima.

Genus Pusiostoma, Swains.

1. *P. mendicarium*, Linn. (*Buccinum*), Rve. Conch. Icon. (*Ricinula*) sp. 8.
Columbella mendicaria, Lamk.
Hab. Awa-Sima.

2. *P. trifasciatum*, Rve. (*Ricinula*), Conch. Icon. sp. 41.
Hab. Okino-Sima.

Subfam. *Rapaninæ.*

Genus Rapana, Schum.

1. *R. bezoar*, Linn. (*Buccinum*), Syst. Nat. ed. 12.
Murex rapiformis, Born, var. *b*.
Purpura bezoar, Kien.
—— (*Rapana*) *Thomasiana*, Crosse.
In Japanese "Nuskai."
Hab. Simoda, Yokohama, Hakodadi.

2. *R. bulbosa*, Soland. (*Buccinum*), Dillw. Cat. of Shells, vol. ii. p. 631.
Murex rapa, Gmel. (not Linn.).
—— *rapiformis*, Born, var. *a*.
Rapa crassa, Mart.
Murex radix, Meusch.
Pyrula rapa, Lamk.
Hab. Satanomosaki, 55 fathoms.

Genus Coralliophila, H. & A. Ad.

C. monodonta, Quoy & Gaim. (*Purpura*), Moll. Voy. de l'Astr. vol. ii.
Purpura madreporarum, Sow.
Hab. Hakodadi Bay (*Schrenck*).

Genus Leptoconchus, Rüpp.

1. *L. Peronii*, Lamk. (*Magilus*), Hist. An. s. Vert. vol. x.
Leptoconchus striatus, Rüpp. Trans. Zool. Soc. Lond. vol. i. p. 259, pl. 23. f. 9, 10.
Hab. Kino-O-Sima, in Madrepores.

2. *L. rostratus*, A. Ad. Ann. & Mag. N. H. 1864.
Hab. Kino-O-Sima, in Madrepores.

Subfam. *Nassinæ.*

Genus Nassa, Martini.

N. mutabilis, Linn. (*Buccinum*), Syst. Nat. ed. 12. p. 1201; Reeve, Conch. Icon. (*Nassa*) sp. 6.

Buccinum gibbum, Brug.
—— *foliosum*, Wood.
Nassa gibba, Roissy.
?—— *sufflata*, Gould, Otia Conch. p. 127.

Hab. Takano-Sima, Mososeki, Seto-Uchi.

Genus Niotha, H. & A. Ad.

1. *N. Cumingii*, A. Ad. (*Nassa*), Proc. Zool. Soc. 1851, p. 98.

   Hab. Tatiyama.

2. *N. marginulata*, Lamk. (*Buccinum*), Hist. An. s. Vert. vol. x. p. 182; Rve. Conch. Icon. (*Nassa*) sp. 43.

   Hab. Satanomosaki, Seto-Uchi.

3. *N. gemmulifera*, A. Ad. (*Nassa*), Proc. Zool. Soc. 1851, p. 99.

   Hab. Seto-Uchi, Akasi, Kino-O-Sima (25 fathoms).

4. *N. globosa*, Quoy & Gaim. (*Buccinum*), Voy. de l'Astr., Zool. vol. ii. tab. 32. f. 25, 27

   Buccinum clathratum, Kien. (not Born).

   Hab. Japan (*Dkr.*).

5. *N. livescens*, Phil. (*Buccinum*), Zeitschr. f. Mal. 1848, p. 135.

   Hab. Japan (*Dkr.*).

6. *N. cœlata*, A. Ad. (*Nassa*), Proc. Zool. Soc. 1851; Rve. Conch. Icon.

   Hab. Mososeki, Seto-Uchi.

Genus Zeuxis, H. & A. Ad.

1. *Z. varicifera*, A. Ad. (*Nassa*), Proc. Zool. Soc. 1851.

   Hab. Tsaulian.

2. *Z. siquijorensis*, A. Ad. (*Nassa*), Proc. Zool. Soc. 1851; Rve. Conch. Icon. *Nassa*, sp. 53.

   Hab. Tsaulian, Tomo, Seto-Uchi.

3. *Z. succincta*, A. Ad. (*Nassa*), Proc. Zool. Soc. 1851; Rve. Conch. Icon. (*Nassa*) sp. 80.

   Hab. Seto-Uchi, Mososeki.

4. *Z. micans*, A. Ad. (*Nassa*), Proc. Zool. Soc. 1851; Rve. Conch. Icon. (*Nassa*) sp. 140.

Hab. Uraga.

5. *Z. clandestina*, A. Ad.

Z. testa ovato-fusiformi, cinerea, obscure fusco reticulata, lævi; anfractibus planiusculis, supremis lævibus; anfractu ultimo transversim valde sulcato, labro callo circumscripto tecto; apertura subrhomboidea; labro intus valde lirato, margine antice integro.

Hab. Seto-Uchi, Idsuma-Nada, Yobuko.

A somewhat doubtful form of *Zeuxis*, marked obscurely like *Nitidella cribraria*, and having many of the characters of the group *Amycla*. The nearest approach, however, is *Nassa micans*, A. Ad., in which the outer lip is crenulated and the upper whorls are costellate and which has all the characters of a *Zeuxis*.

Genus Cæsia, H. & A. Ad.

C. japonica, A. Ad. (*Nassa*), Proc. Zool. Soc. 1851, p. 110.

Hab. Seto-Uchi, Uraga, Kino-O-Sima, Sado.

Genus Hima, Leach.

1. *H. fraterculus*, Dkr. (*Nassa*), Moll. Japon. tab. 1. f. 15.

Hab. Tatiyama, Hakodadi, Simoda, Nagasaki.

2. *H. plebecula*, Gould, (*Nassa*), Otia Conch. p. 128.

Hab. O-Sima.

Genus Hebra, H. & A. Ad.

H. muricata, Quoy & Gaim. (*Buccinum*), Voy. de l'Astr. pl. 32. f. 32, 33.

Hab. Tsaulian, Kino-O-Sima.

Genus Tritia, Risso.

T. festiva, Powis (*Nassa*), Proc. Zool. Soc. 1835, p. 95.

Nassa lineata, Dkr. Moll. Japon. tab. 1. f. 22.

Hab. Hakodadi.

Genus Amycla, H. & A. Ad.

1. *A. varians*, Dkr. Moll. Japon. tab. 1. f. 17.

?*Buccinum scriptum*, Linn., non *Columbella scripta*, Lamk.

Hab. Tatiyama, Hakodadi, Rifunsiri.

2. *A. fasciolata*, Lamk. (*Buccinum*), Hist. An. s. Vert.

?*Columbella trivittata*, Gld.

Hab. Tsus-Sima, on coral.

3. *A. gausapata*, Gould, (*Columbella*), Otia Conch. p. 71.
Hab. Awa-Sima; Tabu-Sima, on the shore.

4. *A. achatina*, Sow. (*Columbella*), Thes. Conch. pl. 39. f. 126.
Hab. Gotto Islands.

Genus DESMOULEA, Gray.

1. *D. japonica*, A. Ad. Proc. Zool. Soc. 1851.
Nassa japonica, Rve. Conch. Icon. sp. 195.
Hab. Japan (*Dr. Siebold*).

2. *D. crassa*, A. Ad. Proc. Zool. Soc. 1851.
Nassa ponderosa, Rve. Conch. Icon. sp. 196.
Hab. Japan (*Dr. Siebold*).

Genus EBURNA, Lam.

E. japonica, Rve. Conch. Icon. (*Eburna*) sp. 3.
Hab. Tatiyama, Simoda, Nagasaki, Sado.

Subfam. *PHOSINÆ.*

Genus PHOS, Montf.

P. varicosus, Gould, Otia Conch. p. 66.
Hab. Satanomosaki, 55 fathoms.

Genus CYLLENE, Gray.

1. *C. pulchella*, Ad. & Rve. Zool. Voy. Sam. pl. 10. f. 11; Sow. Thes. Conch. (*Cyllene*) f. 24, 25.
Hab. Satanomosaki, 55 fathoms.

2. *C. orientalis*, A. Ad. Proc. Zool. Soc. 1850.
Hab. Gotto Islands.

3. *C. glabrata*, A. Ad. Proc. Zool. Soc. 1850; Sow. Thes. Conch. (*Cyllene*) f. 14, 15.
Hab. Satanomosaki, 55 fathoms.

4. *C. fuscata*, A. Ad. Proc. Zool. Soc. 1850; Sow. Thes. Conch. (*Cyllene*) f. 16, 17, 18.
Hab. Kuro-Sima.

5. *C. gibba*, A. Ad.

C. testa ovato-acuminata, lævi, crassa, spira attenuata, apice acuto, obsolete transversim sulcata, albida, maculis spadiceis obscure variegata; anfractu ultimo gibboso, inferne tumido, antice transversim valde sulcato; apertura spiram æquante; labio antice rugoso-plicato; labro margine incrassato, intus valde lirato.

Hab. Kino-O-Sima, on the sands.

This is a small gibbous species, with smooth simple whorls and an attenuated pointed spire.

Fam. **Fasciolariidæ.**

Genus FASCIOLARIA, Lamk.

F. filamentosa, Chemn. (*Fusus*), Conch. Cab. t. 140. f. 1310, 1311.

Neptunea cincta, Link.

Hab. Hakodadi (*Lindholm*), Takano-Sima (*A. Ad.*).

Genus LATHYRUS, Montf.

1. *L.* (*Plicatella*) *polygonus*, Linn. Syst. Nat. ed. 12.
   Hab. Tatiyama.

2. *L. rhodostoma*, Dkr. (*Turbinella*), Moll. Japon. pl. 1. f. 21.
   Hab. Tsaulian.

Fam. **Volutidæ.**

Subfam. *CYMBIINÆ.*

Genus MELO, Humphr.

M. Broderipii, Gray, Sow. Thes. Conch. (*Melo*) sp. 8, f. 26, 27.

Hab. Japan (*Humphr.*).

Subfam. *VOLUTINÆ.*

Genus SCAPHELLA, Swains.

S. (*Alcithoë*) *megaspira*, Sow. Thes. Conch. (*Voluta*) sp. 38, f. 31, 32.

Voluta liriformis, Kien. (not Swains. or Lam.).
—— *Harnillei*, Crosse, Journ. de Conch. 1870, ser. 3. tom. x. pl. 1. f. 5, pl. 2. f. 1.

Hab. Hakodadi Bay, dead on the shore.

Genus FULGORARIA, Schum.

F. fulgura, Mart. (*Voluta*), Sow. Thes. Conch. (*Voluta*) sp. 39, f. 51, 52, 53.

Voluta rupestris, Gmel.
—— *fulminata*, Lamk.

Hab. Korea Strait.

Genus Lyria, Gray.

1. *L. nucleus*, Lamk. (*Voluta*), Sow. Thes. Conch. (*Voluta*) sp. 57, f. 108.

Hab. Tatiyama.

2. *L. cassidula*, Rve., Sow. Thes. Conch. (*Voluta*) sp. 63, f. 130.

Hab. Kino-O-Sima.

Genus Volutomitra, Gray.

V. pusilla, Schrenck (*Voluta*), Moll. Amur-Landes, pl. 17. f. 13, 15.

Hab. Hakodadi Bay (*Schr.*).

Fam. **Cassididæ.**

Genus Semicassis, Klein.

S. japonica, Rve. (*Cassis*), Conch. Icon. sp. 23.

Hab. Tatiyama, Tsusaki, 37 fathoms.

Genus Phalium, Link.

P. strigatum, Linn. (*Buccinum*), Syst. Nat. p. 3477; Rve. Conch. Icon. (*Cassis*) sp. 26.

Buccinum rugosum, Gm.
Cassis undata, Mart.
—— *zebra*, Lamk.
Cassidea areola, Brug. (not Linn.).

Hab. Mososeki, 7 fathoms; Seto-Uchi (Idsuma-Nada).

Genus Casmaria, H. & A. Ad.

C. vibex, Linn. (*Buccinum*), Syst. Nat. ed. 12.

(Var.) *B. erinaceus*, Linn.

Hab. Tatiyama.

A large variety, with the outer lip not denticulate at the margin.

Genus Morum, Bolt.

M. (*Oniscidea*) *cancellatum*, Sow. (*Oniscia*), Genera of Shells, gen. *Oniscia*, f. 1–3; Rve. Conch. Icon. sp. 4.

Cassidaria cancellata, Kien (not Lamk.).

Hab. Gotto, 71 fathoms.

A variety, smaller, more pyriform, the inner lip more granulated, and the outer lip more reflexed and more lirate than the normal form.

Fam. **Doliidæ.**

Genus Dolium, Browne.

D. australe, Chemn. (*Buccinum*), Rve. Conch. Icon. (*Dolium*) sp. 10.

Buccinum chinense, Dillw.
—— *variegatum*, Phil. (not Lamk.).
D. Kieneri, Phil.
In Japanese, "Cimbu."

Hab. Hakodadi, Yokohama, Simoda.

Genus Lagena, Klein.

1. *L. clandestina*, Chemn. (*Murex*), Lamk. An. s. Vert. vol. ix. p. 639.

Triton clandestinus, Rve. Conch. Icon. sp. 13.
Buccinum cincticulum, Meusch.
Nept. doliata, Bolt.

Hab. Kino-O-Sima.

2. *L. rostrata*, Mart. (*Dolium*) pl. 3. f. 1083.

Fusus cutaceus, Lamk.
Cassidaria cingulata, Lamk.
Tritonium undosum, Kien.

Hab. Simidsu.

Fam. **Sycotypidæ.**

Genus Sycotypus, Browne.

1. *S. reticulatus*, Lamk. (*Pyrula*), Hist. An. s. Vert. vol. ix. p. 510.

Hab. Kuro-Sima.

2. *S. papyraceus*, Say (*Ficula*).

Hab. Kuro-Sima, Simoda, Satanomosaki.

L.—*List of Coleoptera received from Old Calabar, on the West Coast of Africa.* By Andrew Murray, F.L.S.

[Continued from vol. ii. p. 111.]

LONGICORNS.

The Lamellicorns are the group which I meant to take next; but my friend M. Candèze, of Liége, who has latterly paid much attention to that group, having been kind enough to undertake the examination and description of the new species belonging to it, I entrusted my specimens of them to him for that purpose. His other engagements, however, have as yet prevented his carrying out his intention; and, after waiting for some time, I have come to the conclusion to postpone the Lamellicorns, and proceed at once with some other group, trusting that M. Candèze may be able to overtake them before I have done. Should he not, I shall then take them myself. I therefore now proceed with the Longicorns, which I take after the Buprestidæ, in preference to any other, on the strength of the general resemblance which the larvæ of these groups have to each other. In a list of this kind it matters little in what order the different larger groups are taken; each of them makes a little independent chapter by itself.

In the arrangement of the Longicorns I have, of course, followed the steps of Prof. Lacordaire in the main; but in a number of minor details I have ventured to deviate from them; and I do so now more than I have done hitherto, because it appears to me that the learned Professor has in none of his previous volumes sacrificed natural affinity to facility of reference so much as in the Longicorns. In his last volumes he frequently acknowledges the artificial character of much of his arrangement. Now the natural relations are precisely the very thing that I am most anxious to elucidate in these papers. Throughout I have written them with one eye on the beetles themselves, and the other on their geographical distribution and their relations to the beetles of other countries. It would therefore be to stultify myself, and sacrifice one of the principal aims which I have in view in these descriptions, were I to bend to the greater authority of M. Lacordaire, and follow him in details of arrangement which are acknowledged by himself, or patent to all, to be inconsistent with the true natural affinities of the species themselves. The great deference which is legitimately due, and which all entomologists must delight to pay, to the author of that wonderful work the 'Genera des Coléoptères,' forbids my acting in contradiction to his views without first making this apology.

The greater number of my Old-Calabar Longicorns have been already described in Guérin's 'Revue et Magasin de Zoologie,' by my friend M. Chevrolat, who was kind enough to undertake that task years ago at my request. A reference to his descriptions would therefore, strictly speaking, be enough; but those who may use this list will probably be glad to have brought to their hand a summary of the characters of at least those species which were new.

Parandridæ.

Parandra, Latr.

Parandra beninensis, Murr. Trans. Linn. Soc. xxiii. p. 452 (1862), pl. 47. fig. 7*a*.

Ferrugineo-fusca, punctata, punctis rugosis, oblongis vel quadratis seu angulatis. ♂ ignot. ♀ Capite fronte inter oculos tenuiter canaliculata medio foveolata utrinque elevata, antice transversim excavata; clypeo prope oculos utrinque carinato, fere trilobato, lobo mediano obtuse subquadrato prominente; mandibulis crassis, convexis, dentatis; thorace transversim subquadrato, marginato, postice angustiore, fortius et rugosius utrinque antice punctato; utrinque bifoveolato, fovea una versus medium posita, altera deltoidea ad basin; angulis anticis subquadratis vix projicientibus, posticis obtusis, lateribus fere rectis; scutello glabro, impunctato; elytris subtricarinatis. Subtus mento rugoso; metasterno et segmentis abdominis glabris, nitidis, haud punctatis, ad latera lævissime subpapillosis, prosterni lateribus sparsim et parcissime et femoribus sat crebre leviter punctatis.

Long 9 lin., lat. 3 lin.

One specimen in my collection.

There is another species of this genus, from Gaboon, described by M. Thomson under the name of *P. gabonica* (Arch. Ent. ii. 145), which corresponds with this in size and colour; it is distinguished from it, however, by the form of the anterior angles of the thorax, which in *P. beninensis* scarcely project at all, and are subquadrate, while in the Gaboon species they project acutely, and the sides of the thorax are slightly rounded. It is, however, very nearly allied to it; and, from the point of view of geographical distribution, they cannot be regarded as other than climatal varieties of a representative of the American Parandras.

The distribution of the genus is remarkable, and deserves attention; for its character and facies are peculiar and well-marked, and the genus isolated and without allies or relations. So much is this the case that, although by very general consent it is placed among the Longicorns, heretics have from time to time appeared who think it ought either to be placed by itself or in other company, as the Cucujidæ or Brenthidæ. Its isolation and well-marked facies are of special value in a geographical point of view. No doubts or difficulty as to the identity of the genus can occur; it may be an aberrant form itself, but we are not troubled with any aberrant forms of its own type.

Lacordaire records thirty-five species of *Parandra*: of these, twenty-eight are American (viz. seven from North America, one from Mexico, three from the West Indies, thirteen from the Columbian district, including New Granada, Columbia, Venezuela, and Cayenne, and three from Brazil), four from Africa (viz. one from Old Calabar, one from Gaboon, and two from the Cape), one from the neighbourhood of the Caspian Sea, and two from New Caledonia. We have here, as I read the distribution, four, if not five, main localities, which either are now or have been at some former period separated from each other by important gaps; and the question presents itself in as unmixed a form as can well be, Are we to suppose that the lands separated by these gaps were at some former period united, or is the wide distribution of *Parandra* due to accidental dispersal or ancient general distribution?

It seems to me that its preponderance in one country and extreme rarity elsewhere are adverse to the idea of its having originally been universally distributed. Where that explanation applies, as, for instance, in the ferns, both fossil remains and present distribution show the same typical forms in abundance in every quarter of the globe. But if we do not give it a general or universal distribution, we must fix on some one or more localities as its aboriginal site or centre of creation (using that term in a wide and liberal sense, and not confounding with it the question of single or multiple original creations); and where we have twenty-eight species in one region as against seven in all the rest, there seem grounds for holding that America was its aboriginal land, and New Granada or its neighbourhood the centre or starting-point of its distribution. Thence there is no difficulty in assuming that it has spread, on the one hand, into North America, and, on the other, into Brazil. It will not be so readily admitted, but I believe it to be equally true, that it has reached West Africa from the Brazilian coast by former and very ancient continuity of land, in the same way that the other South-American types which we have found in Old Calabar have done, and thence in later times spread into the other parts of Africa; and by the same line that the Caffrarian Adesmias have made their way into Mongolia, this genus also has spread to the Caspian Sea. From the other (the western) side of South America it may have in like manner spread, by former more or less interrupted continuity, to New Caledonia, as the genus *Photophorus* has carried representatives of the fireflies out of South America into these islands.

Prionidæ.

DORYCERA, White.

Dorycera spinicornis, Fab.; White, Brit. Mus. Catal. Longicorns, i. p. 13, tab. 1. fig. 1 (1853); also figured by me in Trans. Linn. Soc. xxiii. tab. 47. fig. 8 *a*.

Apparently rare in Old Calabar.

This is another representative of a South-American form in Old Calabar. It has very much the appearance of *Orthomegas corticinus* from Cayenne, but still more that of *Polyoza Lacordairei*, from Brazil. The former is placed near it by Lacordaire, but the latter is removed to a distance in another section. It seems to me that the natural affinities of all three are close together. I by no means desire to exalt one character to the disparagement, much less the exclusion, of others; but I must repeat the conviction I have long held and often urged, that surface and texture deserve much more attention than they usually receive as indications of natural affinity. If that test be applied here, it will bring together a number of opaque, sericeous-surfaced, depressed Prionidæ distinguished by large eyes, spined thorax, and flat or flabellate antennæ, and in particular the American and West-African species I allude to, showing that *Dorycera spinicornis* is a West-African representative of a Brazilian natural group.

MACROTOMA.

1. *Macrotoma palmata*, Fab. Ent. Syst. ii. p. 249.

Apparently rare at Old Calabar.

The genus *Macrotoma* is confined to the Old World, and is most numerous in Africa; so is the whole family of Macrotomidæ, with one exception, a single species forming a separate genus (*Strongylaspis*), which is found in Mexico and Cuba. I am not disposed to refer its presence there to any communication between the west coast of Africa and South America; that communication took place (as I think I can show) before the union of Brazil with the rest of South America. And if *Strongylaspis* were an aberrant form of West-African *Macrotoma* which reached Mexico by filtration through Brazil, it should have left traces in Brazil, which do not exist, at least are not known. We know, however, that Mexico and some other parts of South America preserve traces of communication with Madagascar (where *Macrotoma* also occurs); and I should rather be disposed to look there for the origin or connexion of *Strongylaspis*.

2. *Macrotoma senegalensis*, Oliv. Ent. 66. p. 22. no. 21, pl. 7. fig. 25.

Also rare at Old Calabar.

Mallodon, Serv.

Mallodon Downesii, Hope, Ann. & Mag. Nat. Hist. ser. 1. vol. xi. p. 366.

Tolerably abundant at Old Calabar.

With the exception of one species peculiar to Arabia, part of which, for the purposes of geographical distribution, may be regarded as an appendage of Africa, the Mallodons are confined to America and Africa. The other African species are few in number, consisting of two from West Africa and one from Madagascar, while those in America are more numerous, lending force to the idea which other instances of the same nature have already suggested, that, while there has been a very considerable infusion of South-American blood into West Africa, there has been comparatively little return from Africa to South America.

Cerambicidæ.

Plocæderus, Thoms.

1. *Plocæderus nitidipennis.*

Hammaticherus nitidipennis, Chevr. Rev. et Mag. Zool. 1858, p. 50.

Alatus, niger, nitidus; capite antice trinodoso, carinula sulcata inter oculos; antennis 1mo articulo elongato rubro, 2o–4m nigris, sequentibus fuscis, planatis, angulatis; thorace transverso, valde polito, antice posticeque recto et bis plicato, angulo laterali medio valido obtuso; scutello opaco, semirotundato; elytris lævissime punctulatis, glaberrimis, nitidissimis, viridibus, ad latera et basin igneo vel violaceo micantibus, subrecte parum truncatis; corpore nigrofuscescente, leviter et in pectore dense pubescente, abdomine nitidiore; femoribus (basi et apice exceptis) tibiisque in dimidia parte apicali rubris; tarsis rufo-piceis.

Long. 10–13 lin., lat. $3\frac{1}{2}$–4 lin.

Black. Head with three tubercles in front and a small ridge between the eyes, which is grooved behind, retracted behind into a sort of transverse neck, bearing on that part an ill-defined punctation and transverse wrinkling. Antennæ with the first article thick, elongated, rugose, red, obscure at the tip; second very small; third and fourth swollen at the extremity; all three black, those following brown, flattened and angular at the apex on the exterior side. Thorax transverse; disk large, depressed, only slightly convex, highly polished and finely punctate, straight in front, suddenly constricted and bearing two tubercles intermingled with two or three grooves; base bisinuate, posterior angles feebly reflexed and acuminated; there are two folds along the base following its bisinuation; lateral tubercle strong and obtuse, unequal above, and strongly impressed on the margin. Scutellum semicircular, blackish. Elytra broader than the thorax, three, or in some individuals even four and a half, times as long, subparallel, slightly widened about two-thirds from the base, truncated slightly at the extremity; their surface is covered with a fine punctation, and is very smooth, glabrous, and shining, of a fine brilliant green, which turns into a brilliant igneous or violet reflection on the sides and base; base depressed, shoulders prominent and rounded. Body below blackish brown, with transverse folds under the thorax, covered with a dense, short velvety pile, which, however, is only slight on the breast, with the abdomen more shining, particularly on the margins of the segments. Thighs, with the exception of the base and apex and posterior half of the tibiæ, ferruginous red; tarsi yellowish or rufous brown.

This species resembles in its description the *Hammaticherus glabricollis* of Hope, but differs in various respects. The antennæ and legs in *glabricollis* are described as reddish piceous; and no mention is made of the very striking character the igneous or violet sides and base of the elytra. Nevertheless it may be the same as *H. glabricollis*; but as Hope says that he is acquainted with other metallic species from the same locality, I have less hesitation than I might otherwise have had in regarding it as distinct. It, as well as the next species, approaches, in the form of its antennæ and the structure of its body, to the *H. gigas* and *humeralis* of White.

The commonest species of this genus, but far from abundant.

This type of *Plocœderus* is peculiar to West Africa; and the nearest relations of the African species are the East-Indian.

2. *Plocœderus chloropterus*, Chevr. Rev. et Mag. d. Zool. 1856, p. 566.

Niger, opacus; palpis, antennis (1^o articulo rubido, 5^o–10^m singulatim ad apicem angulosis et parum dilatatis, ultimo emarginato) pedibusque ferrugineis (geniculis obscuris); thorace transversim et recte plicato, in lateribus anticis nodoso, medioque sat valide tuberculato vel fere spinoso; scutello lanugine alba vestito; elytris thorace latioribus, convexiusculis, viridibus, crebre punctatis (fortiter versus basin, leviter versus apicem), alboque breviter setosis, apice recte truncatis et externe et ad suturam dentatis; pectore cum abdomine dense cinereo-villosis.

Long. 11–15 lin., lat. 3–4 lin.

Opaque, black. Head keeled between the eyes, with very fine transverse folds behind. Palpi ferruginous. Antennæ longer and more slender than in the preceding species, ferruginous, with the first article red and punctate, second and third nodulated at the tip, fifth to tenth elongated, depressed, somewhat dilated and angulated at the exterior tip, and terminal article elongate and obliquely emarginate at the apex. Thorax rather longer than broad, with transverse folds and oblique channels from the base on each side of the disk, which turn in and unite about the middle, and then proceed in the dorsal line to the front, the whole producing a somewhat crown-shaped discal island; a strong tubercle on each side in front, followed by a larger one in the middle, terminating in a rather stout short spine. Scutellum triangular, without perceptible punctures, but bearing a whitish velvety pile. Elytra broader than the thorax, convex, rounded subrectangularly on the outside of the shoulder, parallel on the sides, becoming oblique towards the apex, and truncated at the extremity, with the sutural and external angle sharp or toothed; they are broadly depressed at the base, bluish green, and, under the lens, very closely punctured (the punctures of different sizes, and sometimes running into each other, forming rugose punctation) at the base, and very finely and sparsely punctured towards the apex, and from the punctures proceed a short silky pile. Legs ferruginous, obscure at the knees. Breast and abdomen brownish black, clothed with a tolerably thick ashy pile.

I have a variety of larger size, coarser punctation, much larger and darker-coloured antennæ, elytra darker and not so blue, longer pile on the underside, and darker legs, but without any other distinction than an enlargement of all the details.

In describing this species, M. Chevrolat drew attention to its resemblance to the *Hammaticherus viridipennis* of Hope, but remarked that it differed by its smaller size and by its elytra being convex instead of flattened. Specimens subsequently received, more particularly the large variety above mentioned, show that no distinction can be drawn from the size; Mr. Hope gives 12 lines as the size of his species, and that of my specimens ranges from 10 to 15: and the other point of difference, that the elytra are flattened, is founded on error; for Hope's description says nothing about the elytra being flattened. All that he says regarding them is, "Elytris viridibus, ad apicem abrupte truncatis et sub lente subtilissime punctatis." In other points my specimens agree with Mr. Hope's description; but it is very short, and I cannot think he would have overlooked the comparatively strong punctation (under the lens) on the basal portion of the elytra, had it been present in his species. Certainly the description of the elytra as "subtilissime" punctate under the lens does not apply to elytra which are so only towards the apex. My own anticipation is that my species will turn out to be the same as Hope's; but his description does not warrant my acting on this supposition. I find myself therefore constrained to follow the course taken by M. Chevrolat, and treat it as distinct until it be shown to be the same.

[To be continued.]

LI.—*Norwegian Mollusca.* By J. Gwyn Jeffreys, F.R.S.

A few hours' dredging last autumn at Dröbak, in Christianiafiord, produced results of such interest that I am induced to publish a list of the Mollusca which I then procured. Dröbak is a "classical" place, in consequence of the discoveries made there, now almost a century ago, by that great zoologist, Otho Frederick Müller. Dr. George Ossian Sars was my kind guide and companion, and assisted me in the work. The depth at which we dredged was from 40 to 60 fathoms; and it was in some places so close to the shore that littoral species were mixed with those from deepish water. Dredging in a Norwegian fiord is a very different matter from dredging on the coasts of Great Britain. The former can be managed easily between breakfast and dinner, in an inland sea resembling a river, which is frequently as smooth as a mill-pond and has a considerable depth. In the middle of Sognefiord, and within a mile from the land, there is a depth of 661 fathoms. On the other hand the 100-fathom line is more than thirty miles from any part of our own coasts; and the open sea there is always more or less agitated, often rough, and sometimes dangerous.

A list of the Christianiafiord Mollusca was published in 1846 by Herr Asbjörnsen; and Dr. G. O. Sars has within the last month edited a further list, which was prepared by his lamented father shortly before his death. I should not have thought it necessary, or even have presumed, to offer the present contribution, except for the belief that a few remarks on certain species, especially with respect to their geographical and bathymetrical distribution, might be useful. I may observe that the deep-sea exploration last year in Her Majesty's surveying steam-vessel the 'Porcupine,' to which I shall presently have occasion to refer, extended from 47° 30′ to 62° N. lat., and included all our western and northern coasts.

Those species to which an asterisk is prefixed are not in the lists either of Herr Asbjörnsen or of Professor Sars.

BRACHIOPODA.

TEREBRATULA CRANIUM, Müller. British Conchology, ii. p. 11, and v. p. 163, pl. 19. f. 1. Christianiafiord, 5–100 fathoms; Porcupine Expedition, 114–632 f.

T. CAPUT-SERPENTIS, Linné. B. C. ii. 14, and v. 164, pl. 19. f. 2. C. 5–100 f.; P. 30–632 f.

CRANIA ANOMALA, Müll. B. C. ii. 24, and v. 165, pl. 19. f. 6. C. 20–100 f.; P. 30–290 f.

CONCHIFERA.

ANOMIA EPHIPPIUM, L. B. C. ii. 30, and v. 165, pl. 20. f. 1. C. 5–100 f.; P. 10–557 f.

A. PATELLIFORMIS, L. B. C. ii. 34, and v. 165, pl. 20. f. 2. C. 5–100 f.; P. 60–420 f.

PECTEN SEPTEMRADIATUS, Müll. B. C. ii. 62, and v. 164, pl. 23. f. 1. C. 20–230 f.; P. 90–664 f.

P. TIGRINUS, Müll. B. C. ii. 65, and v. 167, pl. 23. f. 2. C. 10–100 f.; P. 64–420 f.

P. TESTÆ, Bivona. B. C. ii. 67, and v. 167, pl. 23. f. 3. C. 10–100 f.; P. 30–164 f.

P. STRIATUS, Müll. B. C. ii. 69, and v. 168, pl. 23. f. 4. C. 10–100 f.; P. 66–420 f.

P. SIMILIS, Laskey. B. C. ii. 71, and v. 168, pl. 23. f. 5. C. 40–140 f.; P. 40–420 f.

P. VITREUS, Chemnitz, and var. *abyssorum*. B. C. v. 168, pl. 99. f. 6. C. 20–230 f.; P. 208–604 f.

P. ARATUS, Gmelin. B. C. ii. 64, and v. 167, pl. 99. f. 5. C. 20–60 f.; P. 155–345 f.

LIMA ELLIPTICA, Jeffreys. B. C. ii. 81, and v. 169, pl. 25. f. 2. C. 12–100 f.; P. 114–208 f.

L. SUBAURICULATA, Montagu. B. C. ii. 82, and v. 169, pl. 25. f. 3. C. 10–60 f.; P. 125–1443 f.

L. LOSCOMBII, G. B. Sowerby. B. C. ii. 85, and v. 170, pl. 25. f. 4. C. 5–100 f.; P. 64–75 f.

L. EXCAVATA, Fabricius. C. 10–140 f.; fossil?

MYTILUS EDULIS, L. B. C. ii. 104, and v. 171, pl. 27. f. 1.

The young only were dredged; and these had probably been removed from the shore by the waves or tide, and carried out into the fiord.

Mytilus phaseolinus, Philippi. B. C. ii. 118, and v. 171, pl. 27. f. 5. C. 15–120 f.; P. 30–110 f.

Modiolaria marmorata, Forbes. B. C. ii. 122, and v. 171, pl. 28. f. 1. C. 10–60 f.; P. 15–80 f.

Nucula sulcata, Bronn. B. C. ii. 141, and v. 172, pl. 29. f. 1. C. 15–100 f.; P. 15–208 f.

N. nucleus, L. B. C. ii. 143, and v. 172, pl. 29. f. 2. C. 5–60 f.; P. 10–1180 f.

N. tumidula, Malm, = *N. pumila*, Lovén, MS. (*N. nucleus*, *β*, in Ind. Moll. Scand.). C. 40–230 f.; P. 420–1476 f. It seems that I was mistaken in referring Malm's species to a variety of *N. nucleus*, although his description may apply as well to that variety as to the present species. *N. proxima* of Say is allied to it.

*N. delphinodonta, Mighels & Adams. C. 60 f.; P. 290–345 f. Gulf of St. Lawrence to Casco Bay, Maine. Mr. M'Andrew dredged it in upper Norway.

Leda pygmæa, Münster. B. C. ii. 154, and v. 173, pl. 29. f. 5. C. 10–100 f.; P. 40–1180 f.

L. minuta, Müll. B. C. ii. 155, and v. 173, pl. 29. f. 6. C. 10–100 f.; P. 40–420 f.

L. lucida, Lov. B. C. v. 173, pl. 100. f. 1. C. 20–230 f.; P. 114–1263 f.

L. frigida, Torell = *Yoldia nana*, Sars. C. 20–230 f.; P. 165–1380 f. I was wrong in believing that this distinct species might be a dwarf variety of *L. lucida*. Prof. Torell described and figured it in his account of the Spitzbergen Mollusca; it is also Greenlandic.

Arca pectunculoïdes, Scacchi. B. C. ii. 171, and v. 175, pl. 30. f. 3. C. 30–100 f.; P. 66–422 f.

*A. glacialis, Gray. B. C. ii. 173. C. 60 f., fossil? P. 290–420 f.

*A. obliqua, Ph. B. C. ii. 175, and v. 175, pl. 30. f. 4. C. 60 f.; P. 164–422 f.

A. nodulosa, Müll. B. C. ii. 180, and v. 176, pl. 100. f. 2. C. 10–60 f.; P. 155–363 f.

Lepton nitidum, Turton. B. C. ii. 198, and v. 177, pl. 31. f. 3. C. 40–60 f.

Montacuta substriata, Mont. B. C. ii. 205, and v. 177, pl. 31. f. 6. C. 2–100 f.; P. 73–420 f.

*M. bidentata, Mont. B. C. ii. 208, and v. 177, pl. 31. f. 8. C. 40–100 f., and var. *triangularis*; P. 3–1366 f.

*M. Dawsoni, Jeffr. B. C. ii. 216, and v. 178, pl. 31. f. 7.

C. 40–60 f.; P. 30–40 f. Greenland (Möller); Spitzbergen (Torell).

*MONTACUTA TUMIDULA, Jeffr. B. C. v. 177, pl. 100. f. 5. C. 40–60 f.

KELLIA SUBORBICULARIS, Mont. B. C. ii. 225, and v. 179, pl. 32. f. 2. C. 10–60 f.; P. 10–164 f.

AXINUS FLEXUOSUS, Mont. B. C. ii. 247, and v. 179, pl. 33. f. 1. C. 10–230 f., and var. *Sarsii*; P. 3–557 f.

A. CROLINENSIS, Jeffr. B. C. ii. 250, and v. 180, pl. 33. f. 2. C. 40–230 f.; P. 90–1476 f.

A. EUMYARIUS, Sars. C. 40–230 f.

A. FERRUGINOSUS, Forb. B. C. ii. 251, and v. 180, pl. 33. f. 3. C. 50–230 f.; P. 40–557 f.

CARDIUM ECHINATUM, L. B. C. ii. 270, and v. 181, pl. 34. f. 2. C. 10–80 f.; P. 15–114 f.

C. FASCIATUM, Mont. B. C. ii. 281, and v. 181, pl. 35. f. 3. C. 10–180 f.; P. 30–75 f.

C. EDULE, L. B. C. ii. 286, and v. 182, pl. 35. f. 5. C. 0–50 f., in the latter case young and probably drifted; P. 3 f.

C. MINIMUM, Ph. B. C. ii. 292, and v. 182, pl. 35. f. 6. C. 10–100 f.; P. 15–542 f.

ISOCARDIA COR, L. B. C. ii. 298, and v. 182, pl. 36. f. 1. C. 20–230 f.; P. 106–1380 f. I have a complete and connecting series, from the adult to the fry or very young, which proves that the latter is the *Kellia abyssicola* of Forbes, *Venus miliaris* of Philippi, and *Kelliella abyssicola* of Sars. Typical specimens of all these so-called species are now before me. The fry swarm in myriads on the surface of the mud in deep water. The adults bury themselves in the mud beyond the reach of a light dredge, such as is generally used in the Norwegian fiords; but they may be seen, in a fossil state, imbedded in the brick-clay near Christiania. In its earliest state the shell has none of the fine bristly epidermis which clothes it at a later period. The remarks of Prof. Sars on the differences observable in the animal and shell of *Isocardia cor* and his *Kelliella abyssicola* are perfectly correct; but such differences result from altered conditions of growth. Some of Forbes's Ægean specimens named by him *Kellia abyssicola* belong to *Axinus ferruginosus*, and others to the present species; his description will suit either.

CYPRINA ISLANDICA, L. B. C. ii. 304, and v. 182, pl. 36. f. 2. C. 15–60 f.; P. 12–40 f.

ASTARTE SULCATA, Da Costa. B. C. ii. 311, and v. 183, pl. 37. f. 1. C. 20–120 f.; P. 15–420 f.

A. COMPRESSA, Mont. B. C. ii. 315, and v. 183, pl. 37. f. 3. C. 40–100 f.; P. 40 f.

Venus ovata, Pennant. B. C. ii. 342, and v. 184, pl. 39. f. 1. C. 10–100 f.; P. 10–1366 f.

Tellina calcaria, Ch. B. C. ii. 389, and v. 187. C. 0–40 f.; P. 40–345 f.

*Mactra subtruncata, Da C. B. C. ii. 419, and v. 188, pl. 43. f. 3. C. 40–60 f.; P. 15–1366 f.

Scrobicularia nitida, Müll. B. C. ii. 436, and v. 189, pl. 45. f. 2. C. 20–230 f.; P. 3–2435 f. Living at the last-mentioned depth, as well as at 2090 f.

*Lyonsia arenosa, Möller (*Pandorina*). C. 40 f. Greenland (Möller); Wellington Channel (Belcher); Spitzbergen (Torell); Upper Norway (M'Andrew).

Thracia papyracea, Poli. B. C. iii. 36, and v. 191, pl. 48. f. 4. C. 10–60 f.; P. 64–164 f.

*T. truncata, Brown. B. C. iii. 43. C. 40 f., fossil?

Neæra abbreviata, Forb. B. C. iii. 48, and v. 191, pl. 49. f. 2. C. 40–120 f.; P. 165–183 f.

N. costellata, Deshayes. B. C. iii. 49, and v. 191, pl. 49. f. 3. C. 10–100 f.; P. 96–664 f.

N. rostrata, Spengler. B. C. iii. 51, and v. 191, pl. 49. f. 4. C. 10–100 f.; P. 85–183 f.

N. obesa, Lov. C. 40–230 f.; P. 125–2435 f. Living at the last-mentioned depth. My reference of this species to *N. cuspidata* (B. C. v. 192) was erroneous: I am now satisfied that they are distinct.

Corbula gibba, Olivi. B. C. iii. 56, and v. 192, pl. 99. f. 6. C. 3–100 f., and var. *rosea*, dwarfed; P. 3–1476 f.

Mya truncata, L. B. C. iii. 66, and v. 192, pl. 50. f. 2. C. 0–40 f.; P. 3–66 f. In the last case apparently fossil, and belonging to the variety *udderallensis*.

Panopea plicata, Mont. B. C. iii. 375, and v. 192, pl. 51. f. 1. C. 20–100 f.; P. 15–33 f.

Saxicava rugosa, L., var. *arctica*. B. C. iii. 82, and v. 192, pl. 51. f. 4. C. 8–100 f.; P. 15–420 f.

Xylophaga dorsalis, Turt. B. C. iii. 120, and v. 193, pl. 53. f. 4. C. 10–60 f.; P. 364 f. Not living in the last case, the shell having probably been dropped from floating wood.

SOLENOCONCHIA.

Siphonodentalium lofotense, Sars. B. C. v. 395, pl. 101. f. 2. C. 40–200 f.; P. 30–1180 f.

S. quinquangulare, Forb. C. 40–300; P. 40–725 f.

Cadulus subfusiformis, Sars. B. C. v. 196, pl. 101. f. 3. C. 40–230 f.; P. 114–1180 f.

Dentalium entalis, L. B. C. iii. 191, and v. 197, pl. 55. f. 1. C. 10–100 f., and var. *infundibulum*; P. 15–664 f.

DENTALIUM ABYSSORUM, Sars. B. C. iii. 197, and v. 197, pl. 101. f. 1. C. 30–230 f.; P. 90–1476 f.

GASTROPODA.

CHITON HANLEYI, Bean. B. C. iii. 215, and v. 198, pl. 55. f. 5. C. 25–60 f. P. 30–345 f.

C. CANCELLATUS (Leach ?), G. B. Sowerby, jun., = *C. alveolus*, Sars. B. C. iii. 217, and v. 198, pl. 56. f. 1. C. 25–60 f.

C. CINEREUS, L. B. C. iii. 218, and v. 198, pl. 56. f. 2. C. 5–100 f.; P. 10–40 f.

C. ALBUS, L. B. C. iii. 220, and v. 199, pl. 56. f. 3. C. 10–60 f.

*C. RUBER (L.), Lowe. B. C. iii. 224, and v. 199, pl. 56. f. 4. C. 50–100 f.

TECTURA TESTUDINALIS, Müll. B. C. iii. 246, and v. 200, pl. 58. f. 3. C. 0–40 f.

T. VIRGINEA, Müll. B. C. iii. 248, and v. 200, pl. 58. f. 4. C. 0–100 f.; P. 10 f.

T. FULVA, Müll. B. C. iii. 250, and v. 200, pl. 58. f. 5. C. 10–140 f.; P. 15–90 f.

LEPETA CÆCA, Müll. B. C. iii. 252, and v. 200, pl. 58. f. 6. C. 0–100 f.

*PROPILIDIUM ANCYLOÏDES, Forb. B. C. iii. 254, and. v. 200, pl. 58. f. 7. C. 40–60 f.; P. 90–1366 f.

*FISSURISEPTA PAPILLOSA, Seguenza (Annali dell' Accademia degli Aspiranti Naturalisti, 3ª serie, vol. ii. 1862, t. iv. f. 2, 2ª, 2ᵇ). I dredged at Dröbak three specimens of this extraordinary species; all were dead, and have a fossilized appearance. The shell is conical, with a round hole at the apex and an internal plate or septum, thus forming a link between *Propilidium* and *Fissurella*. Prof. Seguenza discovered it, with *Puncturella noachina*, *Emarginula crassa*, and other northern species, in what he considers the upper strata of the Miocene formation, at Rometta, near Messina; and he most obligingly presented me with specimens, which I have now had the unexpected opportunity of comparing with those from Norway. If this formation at Rometta be really Miocene, the occurrence of *Fissurisepta papillosa* at Dröbak, whether in a living or fossil state, is very wonderful.

PUNCTURELLA NOACHINA, L. B. C. iii. 257, and v. 200, pl. 59. f. 1. C. 10–60 f.; P. 15–420 f.

EMARGINULA FISSURA, L. B. C. iii. 259, and v. 230, pl. 59 f. 2. C. 20–60 f., and var. *incurva*; P. 10–420 f.

E. CRASSA, J. Sowerby. B. C. iii. 263, and v. 200, pl 59 f. 4 C. 10–100 f.; P. 90–155 f.

CAPULUS HUNGARICUS, L. B. C. iii. 269, and v. 201, pl. 59. f. 6. C. 5–60 f.; P. 30–180 f.

SCISSURELLA CRISPATA, Fleming. B. C. iii. 283, and v. 201, pl. 60. f. 3. C. 40–120 f.; P. 164–725 f. As I suspected, *S. angulata* of Lovén is a large form of this species. The animal not having been sufficiently described, I subjoin an extract from my notes:—

BODY milk-white, with a tinge of yellowish brown in front: *head* thick, snout-shaped: *tentacles* conical, ciliated: *eyes* small, one at the outer base of each tentacle: *foot* double-edged and bilobate in front, abruptly pointed behind; its tail or extremity is pinched up and grooved underneath: *appendages* or pedal filaments as in *Trochus*, but more numerous (eight on each side); these are angulated and finely ciliated; a white eye-spot is at the base of each filament. The slit in the shell serves for excretal purposes; the fæces are worm-shaped, long, and are visible through the shell. The animal is shy and delicate, dying soon after being put in a phial of sea-water.

TROCHUS TUMIDUS, Mont. B. C. iii. 307, and v. 203, pl. 62. f. 2. C. 10–100 f.: P. 10–85 f.

T. CINERARIUS, L. B. C. iii. 309, and v. 203, pl. 62. f. 3. C. 10–60 f.: P. 0–10 f.

T. MILLEGRANUS, Ph. B. C. iii. 325, and v. 204, pl. 63. f. 4. C. 10–100 f.; P. 90–190 f. Live specimens from the last depth were prettily spotted.

LACUNA DIVARICATA, Fabricius. B. C. iii. 346, and v. 204, pl. 64. f. 3. C. 5–100 f., drifted into deeper water; P. 0–3 f.

LITTORINA RUDIS, Maton. B. C. iii. 364, and v. 206, pl. 65. f. 3. C. 0–80 f., drifted from the shore; P. 0.

L. LITOREA, L. B. C. iii. 368, and v. 206, pl. 65. f. 4. C. 0–80 f., drifted; P. 0.

*RISSOA RETICULATA, Mont. B. C. iv. 12, and v. 207, pl. 66. f. 5. C. 40–60 f.

*R. CIMICOÏDES, Forb. B. C. iv. 14, and v. 207, pl. 66. f. 6. C. 40–60 f.; P. 90–422 f.

*R. JEFFREYSI, Waller. B. C. iv. 15, and v. 207, pl. 66. f. 7. C. 40–100 f.; P. 183 f.

R. PUNCTURA, Mont. B. C. iv. 17, and v. 207, pl. 66. f. 8. C. 0–100 f.; P. 25–33 f.

R. ABYSSICOLA, Forb. B. C. iv. 19, and v. 207, pl. 66. f. 9. C. 40–230 f.; P. 165 f.

R. ZETLANDICA, Mont. B. C. iv. 20, and v. 207, pl. 67. f. 1. C. 30–60 f.; P. 208–808 f.

R. PARVA, Da C., and var. *interrupta*. B. C. iv. 23, and v. 207, pl. 67. f. 3, 4. C. 0–100 f., probably drifted from low-water mark; P. 0–10 f.

R. INCONSPICUA, Alder. B. C. iv. 26, and v. 207, pl. 67. f. 5. C. 0–100 f.; P. 3 f.

*R. TURGIDA, Jeffreys.

SHELL forming a short cone, rather thin, nearly transparent, and glossy: *sculpture* consisting of extremely delicate and close-set spiral striæ (which are microscopic), and a very fine but conspicuous thread-like marking round the periphery: *colour* white: *spire* bluntly pointed: *whorls* five, tumid; the last occupies three-fourths of the spire: *suture* deep: *mouth* roundish: *outer lip* thin: *inner lip* filmy, and scarcely perceptible: *umbilical chink* narrow but distinct: *operculum* ear-shaped, with a very small spire and strong flexuous lines of growth. L. 0·075, B. 0·05.

Allied to *R. inconspicua*; but the difference will appear by a comparison of the description of each.

Not uncommon at Dröbak and Vallö, from 40 to 100 f. Owing to my not being provided with proper sieves, I did not at the time detect this small species in the dredged material; and therefore I could not observe the animal. I would again venture to protest against the division of *Rissoa* into several genera, such as *Alvania* and *Cingula*, without a single distinctive character being established. It is certainly not a scientific mode of classification. But naturalists must please themselves!

*HYDROBIA ULVÆ, Penn. B. C. iv. 52, and v. 208, pl. 69. f. 1. C. 40–100 f., probably drifted; P. 3 f., and var. *Barleei*, 1366 f., living, but possibly also drifted.

H. VENTROSA, Mont. B. C. i. 52, and v. 152, pl. 4. f. 7. This, with several land- and freshwater shells, were dredged in deep water; but they were dead, and had evidently been carried into the fiord by streams.

CÆCUM GLABRUM, Mont. B. C. iv. 77, and v. 209, pl. 70. f. 5. C. 40–100 f.

TURRITELLA TEREBRA, L. B. C. iv. 80, and v. 209, pl. 70. f. 6. C. 5–80 f.; P. 10–422 f.

SCALARIA TREVELYANA, Leach. B. C. iv. 93, and v. 209, pl. 71. f. 4. C. 40–100 f.; P. 10–458 f.

*ACLIS WALLERI, Jeffr. B. C. iv. 105, and v. 210, pl. 72. f. 4. C. 40–60 f.; P. 422–1380 f.

ODOSTOMIA CLAVULA, Lov. B. C. iv. 118, and v. 211, pl. 73. f. 1. C. 40–60 f.; P. 25–40 f.

O. RISSOÏDES, Hanley. B. C. iv. 122, and v. 211, pl. 73. f. 4. C. 30–100 f.

*ODOSTOMIA CONOÏDEA, Brocchi. B. C. iv. 127, and v. 211, pl. 73. f. 6. C. 40–100 f.; P. 25–208 f.

O. ACUTA, Jeffr. B. C. iv. 130, and v. 211, pl. 73. f. 8. C. 40–120 f.

O. UNIDENTATA, Mont. B. C. iv. 134, and v. 211, pl. 74. f. 1. C. 30–100 f.; P. 30–40 f.

*O. TURRITA, Hanl. B. C. iv. 135, and v. 211, pl. 74. f. 2. C. 40–60 f.

O. INSCULPTA, Mont. B. C. iv. 139, and v. 211, pl. 74. f. 4. C. 30–100 f.

*O. WARRENI, Thompson. B. C. iv. 143, and v. 212, pl. 102. f. 2. C. 40–100 f.

O. SPIRALIS, Mont. B. C. iv. 154, and v. 213, pl. 75. f. 3. C. 10–60 f.

O. EXIMIA, Jeffr. B. C. iv. 155, and v. 213, pl. 75. f. 4. C. 30–100 f.; P. 420 f. The Norwegian are larger than British specimens, and have a more conspicuous tooth.

O. SCALARIS, Ph., var. *rufescens.* B. C. iv. 160, and v. 213, pl. 75. f. 7. C. 10–80 f.

O. RUFA, Ph., var. *fulvocincta.* B. C. iv. 162, and v. 213, pl. 76. f. 2. C. 20–100 f.; P. 25–208 f.

*O. SCILLÆ, Scacchi. B. C. iv. 169, and v. 213, pl. 76. f. 5. C. 40–60 f., fossil?; P. 25–370 f.

O. ACICULA, Ph., and var. *ventricosa.* B. C. iv. 170, and v. 213, pl. 76. f. 6, 7. C. 30–100 f.; P. 25–1366 f.

*EULIMA POLITA, L. B. C. iv. 201, and v. 214, pl. 77. f. 3. C. 40–60 f., fossil?

E. INTERMEDIA, Cantraine. B. C. iv. 203, and v. 214, pl. 77. f. 4. C. 30–100 f.

E. DISTORTA, Desh., and var. *gracilis.* B. C. iv. 205, and v. 214, pl. 77. f. 5. C. 40–100 f.; P. 15–164 f.

E. STENOSTOMA, Jeffr. B. C. iv. 207, and v. 215, pl. 77. f. 6. C. 40–230 f.; P. 64–290 f.

E. BILINEATA, Ald. B. C. iv. 210, and v. 215, pl. 77. f. 8. C. 25–60 f.; P. 40–422 f. Living specimens from the last depth had the usual bright-coloured bands, and their animals very distinct eyes.

*NATICA GRŒNLANDICA, Beck. B. C. iv. 216, and v. 215, pl. 78. f. 2. C. 40–60 f., fossil?; P. 173–725 f.

N. ALDERI, Forb. B. C. iv. 224, and v. 215, pl. 78. f. 5. C. 15–100 f.; P. 10–420 f.

N. MONTACUTI, Forb. B. C. iv. 227, and v. 215, pl. 78. f. 6. C. 15–120 f.; P. 30–584 f.

N. AFFINIS, Gm. B. C. iv. 229, and v. 215, pl. 102. f. 3. C. 40–120 f.; P. 203–664 f.

VELUTINA LÆVIGATA, Penn. B. C. iv. 240, and v. 216, pl. 79. f. 4. C. 10–100 f.

ADMETE VIRIDULA, Fabr. B. C. iv. 248, and v. 216. C. 20–230 f.; P. 114–420 f.

APORRHAÏS PES-PELECANI, L. B. C. iv. 250, and v. 216, pl. 80. f. 1. C. 5–100 f.; P. 10–422 f.

CERITHIUM METULA, Lov. B. C. iv. 256, and v. 217, pl. 80. f. 3. C. 30–100 f.; P. 114–862 f.

C. RETICULATUM, DaC. B. C. iv. 258, and v. 217, pl. 80. f. 4. C. 20–100 f.; P. 3–74 f.

C. PERVERSUM, L. B. C. iv. 261, and v. 217, pl. 80. f. 5. C. 10–70 f. From Prof. Möbius's notes and drawing, which he was so good as to show me at Kiel, it appears that the animal differs considerably from that of *Cerithium*, particularly in respect of the foot and odontophore. I would consequently adopt the genus *Triforis* of Deshayes for this species.

*CERITHIOPSIS COSTULATA, Möll. B. C. iv. 272, and v. 217, pl. 81. f. 5. C. 40–60 f., fossil?; P. 18–420 f.

BUCCINUM UNDATUM, L., and var. *zetlandica*. B. C. iv. 285, and v. 218, pl. 82. f. 2, 5. C. 0–60 f.; P. 30–180 f.

TROPHON BARVICENSIS, Johnston. B. C. iv. 318, and v. 218, pl. 84. f. 5. C. 30–230 f.; P. 15–458 f.

T. CLATHRATUS, L. B. C. iv. 321. C. 20–60 f.; P. 155–557 f.

T. MÖRCHI, (*Morchii*) Malm, = *Bela demersa*, Tiberi. C. 30–230 f.; Corsica (Tiberi)! Sars placed this remarkable little shell in the genus *Pleurotoma*; but it has no fissure or notch, and the apex is that of *Trophon*. It, however, wants an operculum, the canal is very short, and the sculpture is peculiar, so that it may constitute the type of a new genus, say *Taranis*†. This is truly one of the "sea's rich gems."

NASSA RETICULATA, L. B. C. iv. 346, pl. 87. f. 3. C. 2–70 f.; P. 13 f.

DEFRANCIA LINEARIS, Mont. B. C. iv. 368, and v. 220, pl. 89. f. 2. C. 10–60 f.; P. 13–173 f.

PLEUROTOMA COSTATA, Donovan. B. C. iv. 379, and v. 220, pl. 90. f. 3. C. 10–100 f.; P. 10–208 f.

*P. BRACHYSTOMA, Ph. B. C. iv. 382, and v. 220, pl. 90. f. 5. C. 50–100 f.; P. 15–40 f.

P. NIVALIS, Lov. B. C. iv. 388, and v. 220, pl. 91. f. 4. C. 40–120 f.; P. 155–422 f.

P. TURRICULA, Mont. B. C. iv. 395, and v. 222, pl. 91. f. 7. C. 30–120 f.; P. 10–130 f.

P. TREVELYANA, Turt. B. C. iv. 398, and v. 222, pl. 91. f. 8. C. 6–60 f.

† The name of a heathen god. See Wordsworth's 'Excursion,' 9th book, p. 340.

Pleurotoma mitrula (*Tritonium*), Lov., = *P. cylindracea* Möller)?, var. *alba*, Sars. C. 40–100 f.

*P. declivis (*Tritonium*), Lov. C. 20–100 f.; P. 64–420 f.

Cylichna acuminata, Bruguière. B. C. iv. 411, and v. 222, pl. 93. f. 1. C. 20–80 f.; P. 25–40 f. Sars has described and figured the animal as having separate, long, leaf-like tentacles (folded back on the sides of the shell in front), with minute eyes at their outer bases; and the foot is not expanded laterally or behind. This species must be placed in the genus *Rhizorus* of De Montfort, or *Volvula* of A. Adams.

*C. nitidula, Lov. B. C. iv. 412, and v. 222, pl. 93. f. 2. C. 40–100 f.; P. 25–40 f.

C. alba, Brown. B. C. iv. 417, and v. 223, pl. 93. f. 6. C. 10–120 f.; P. 203–1366 f.

Utriculus truncatulus, Brug. B. C. iv. 421, and v. 223, pl. 94. f. 2. C. 11–80 f.

U. expansus, Jeffr. B. C. iv. 426, and v. 223, pl. 94. f. 6. C. 40–120 f.; P. 165 f.

U. hyalinus, Turt. B. C. iv. 427, and v. 223, pl. 94. f. 7. C. 40–60 f.; P. 25–33 f.

U. globosus, Lov., = *Utriculopsis vitrea*, Sars. B. C. v. 223, pl. 102. f. 8. C. 30–120 f.; P. 542 f. The spire is visible in young, but sunken and nearly concealed in full-grown specimens.

Actæon tornatilis, L. B. C. iv. 433, and v. 224, pl. 95. f. 2. C. 10–60 f.; P. 13–420 f.

Scaphander librarius, Lov. B. C. iv. 446, and v. 224, pl. 102. f. 9. C. 40–140 f.; P. 290–1263 f.

Philine scabra, Müll. B. C. iv. 447, and v. 224, pl. 96. f. 1. C. 10–140 f.; P. 25–542.

P. quadrata, S. Wood. B. C. iv. 452, and v. 224, pl. 96. f. 4. C. 30–230 f.; P. 420–1215.

P. punctata, Clark. B. C. iv. 453, and v. 224, pl. 96. f. 5. C. 30–60 f.

PTEROPODA.

Spirialis retroversus, Flem. B. C. v. 115, pl. 98. f. 4. C. 40–100 f.; P. 25–173 f. In all these cases dropped from the surface of the sea, or voided by fishes and oceanic *Hydrozoa*.

Besides the Mollusca, Foraminifera abounded in great variety; these I have placed in the excellent charge of Dr. Carpenter. I also found some sponge-spicules, which Dr. Bowerbank tells me belong to *Geodia Barretti*, an undescribed species.

MISCELLANEOUS.

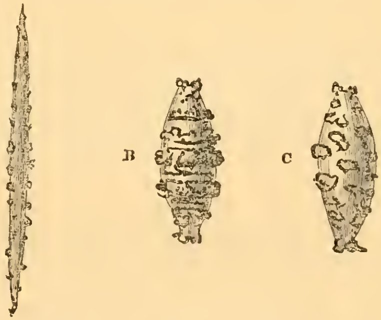
On Anthozoanthus parasiticus, *Deshayes*, MS. (Algiers.) By H. J. Carter, F.R.S. (In a letter to Dr. J. E. Gray.)

This coral is figured, but not described, in Schleiden, 'Das Meer,' fig. 4.

Spicules calcareous, fusiform, tuberculated, some narrow, others thick, variable in length; the longest of the former 1-90th, the longest of the latter 1-180th of an inch; the narrow ones chiefly confined to the polypes, arranged obliquely (?) and parallel, embracing; the thicker ones arranged horizontally (?), interlocking with each other, as if formed in cells of this shape originally interlocking with each other; composing the greater part of the mass or cortex, which is parasitic upon a small, horny, branched stem.

As the narrow spicules are chiefly confined to the polypes, so these are the spicules which are chiefly coloured—red and yellow mixed in one of the specimens (the red-), and yellow only in the other (the yellow-polyped specimen), the red and yellow colours of their points respectively being thus produced.

The tubercles on the narrow fusiform spicules are more or less evenly scattered over the surface (A), from one end to the other, while those of the thicker ones are arranged in three or more bands or

A  B C

rings, with plain intervals or rings (B) between them constricted; or the tubercles may be arranged irregularly throughout the shaft (C), whose extremities are also always tuberculated.

The two specimens, viz. the red- and yellow-polyped, are the same species.

It seems to me that the longer fusiform spicules generally run up round the polype, perhaps obliquely extending into the base of the tentacles.

Notes on Myriosteon. By H. J. Carter, F.R.S.

(In a letter to Dr. J. E. Gray.)

I can find no note in my journal of the piece of *Myriosteon* I took out from a Ray's nose on the south-east coast of Arabia—

nothing but mention of a set of placoid teeth, upper and under, of a species of *Myliobatis*, which I remember to have extracted from the remnants of another old dried Ray on the beach at the same time, and which I finally deposited in Prof. Huxley's hands in the Museum of Economic Geology. What became of the piece of *Myriosteon* I have forgotten altogether.

But that it *did come from the snout of a Ray*, and not of a *Pristis*, the little preparation I now send you seems to confirm.

In this preparation (taken from a *young* Thornback, which I found on the beach at Budleigh-Salterton on the 12th May) you will see your *Myriosteon* in miniature.

If you hold it up between you and the light, you will see, halfway up, on its surface the radiated osselet structures with a common lens, and with a higher power the veritable osselet structure of your *Myriosteon*.

Now, if you look into the cavity of the cranium (a portion of which still adheres to the snout), you will observe that this cavity is continued on into the *Myriosteon*; and a little imagination will enable you to see that this cavity represents the cribriform plate of the ethmoid bone prolonged into a conical tube, the holes of which, for the issue of the olfactory nerves, may be the holes which exist on each side of your *Myriosteon Higginsii*.

Geographical Distribution of Australian Whales.

I have just received a pair of the ear-bones of *Poescopia Novæ Zelandiæ* and some blades of the baleen of *Balæna marginata*, direct from the sea near Swan River, showing that both these species are common to the west coast of Australia and New Zealand.—J. E. Gray.

On the Structure of a Fern-stem from the Lower Eocene of Herne Bay, and on its Allies, recent and fossil. By W. Carruthers, Esq., F.L.S., F.G.S.

The author described the characters of the fossil-stem of a Fern obtained by George Dowker, Esq., F.G.S., from the beach at Herne Bay, and stated that in its structure it agreed most closely with the living *Osmunda regalis*, and certainly belonged to the Osmundaceæ. The broken petioles show a single crescentic vascular bundle. The section of the true stem shows a white parenchymatous medulla, a narrow vascular cylinder interrupted by long slender meshes from which the vascular bundles of the petioles spring, and a parenchymatous cortical layer. The author described the arrangement of these parts in detail, and indicated their agreement with the same parts in *Osmunda regalis*. He did not venture to refer the Fern, to which this stem had belonged, positively to the genus *Osmunda*, but preferred describing it as an *Osmundites*, under the name of *O. Dowkeri*. The specimen was silicified: and the author stated that even the starch-grains contained in its cells, and the mycelium of a parasitic Fungus traversing some of them, were perfectly represented. Its precise origin was unknown; it was said to be probably derived from the London Clay, or from the beds immediately below.—*Proc. Geol. Soc.* March 9, 1870.

Observations on the Ornithological Fauna of the Bourbonnais during the Middle Tertiary Period. By M. A. Milne-Edwards.

When I commenced the palæontological investigation of the tertiary strata of the Bourbonnais, I was far from thinking that the birds whose remains are buried in those deposits would furnish clearer and more precise indications as to the general character of the miocene fauna of that part of France than the fossil mammalia and reptiles of the same region. In fact, birds, being endowed with powerful organs of locomotion, are in general less settled than the species belonging to the classes mammalia and reptiles.

When I presented to the Academy my work on the fossil birds of France, there was nothing to justify me in expressing an opinion of this kind; but by pursuing my researches upon this subject I have arrived at new results, which seem to me of great importance and of a nature to enlighten us as to the character of this tertiary fauna better than the palæontological history of the other vertebrate animals of the basin of the Allier, in the present state of our knowledge.

Among the fossil birds the presence of which I have recently ascertained in the tertiary deposits of Saint-Gerand-le-Puy and Langy, there are several which give to this ancient fauna an almost intertropical and, especially, an African character—namely, Parrots, Trogons, Salanganes, Gangas, Marabous, and Secretaries or Serpent-eaters.

The Parrots constitute a perfectly natural family, well-marked and easily characterized by the structure of the bones as well as by the external form. It occupies the hottest regions in both hemispheres, and has no representatives in the present day either in Europe or in extratropical Asia, or in the part of America situated north of the Gulf of Mexico.

In the tertiary period there existed in France a parrot which, in its osteological characters, differs notably from the Australian types, as also from the maccaws and other American genera, and presents much analogy with certain African species, especially *Psittacus erythacus* of Senegal and South Africa. This tertiary parrot (which I have called *Psittacus Verreauxii*, and which I shall describe in one of the next parts of my work on fossil birds) is the sole example of a parrot which lived in geological times, and it establishes the first mark of resemblance between the miocene ornithological faunaa of the Allier and the existing fauna of Africa.

The Couroucous or Trogons, the plumage of which is not less brilliant than that of the Parrots, now inhabit the hottest parts of the globe; they occur in America, in Asia, and in Africa, but only in the torrid zone; but I have collected bones undoubtedly belonging to a Trogon in the deposits of Saint-Gerand-le-Puy. These birds usually live in well-wooded places, where they feed on insects; thus the presence of *Trogon gallicus* in the Bourbonnais tends to prove the existence of considerable forests in the vicinity of the lakes of this part of France.

The Gangas or Sandgrouse live at present in Africa and in the warmer regions of Asia: they are only birds of passage in the south of Europe; but they are represented in the ancient fauna of the Allier by a peculiar species, to which I have given the name of *Pterocles sepultus*.

The Salanganes (which have been confounded with the Swallows by most ornithologists, but which really differ therefrom greatly in their mode of organization, and belong to the family of the Swifts or Cypselidæ) now inhabit only India, Cochin China, some of the Polynesian islands, and the Mascarene islands. One species of this group, very nearly allied to the existing species, has left its remains in the tertiary strata of the Bourbonnais.

A large bird of the stork family seems to represent, in this region, the Marabous, which now-a-days occur from the Senegal to Cochin China.

The discovery of a secretary-bird in the midst of this ancient population seems to me very interesting. *Serpentarius* or *Gypogeranus reptilivorus*, which occurs in Africa, from Abyssinia to the neighbourhood of the Cape of Good Hope, is at present the sole representative of a peculiar family of predaceous birds organized for running rather than for flying. Now, as I have shown with regard to the flamingoes, the zoological groups which, at the present day, are represented only by a single species, or by a very small number of species, probably at an ancient period possessed a numerical importance not inferior to that of the other equivalent natural groups. The existence of a second member of the family Serpentariidæ in the miocene epoch therefore seems to me to be an important zoological fact; and the presence of these large birds of prey in France and in Africa at different periods constitutes a new feature of resemblance between the miocene fauna of the Bourbonnais and the existing fauna of the African continent. I have as yet found only a single bone of the foot of this fossil secretary-bird; but the organic characters of this part of the skeleton are so distinct that there can be no uncertainty as to the determination of the type to which the bird from which this fragment was derived belonged.

In my first work on fossil birds, submitted to the Academy in 1865, I showed that at the miocene epoch flamingoes, ibises, and pelicans inhabited the shores of the lakes of the Bourbonnais; but it was necessary, to be very reserved as to the conclusions which might be drawn from these facts with regard to the general character of the ornithological population. The fresh discoveries which I have just made known fully confirm the conjectures which I had formed upon this subject, and lead me to think that, at the period when the lower miocene beds of the Allier were deposited, the biological conditions in that part of France must have been nearly the same as those which exist now-a-days in certain tropical regions.—*Comptes Rendus*, March 14, 1870, p. 557.

On the Pancreas in Osseous Fishes, and on the Nature of the Vessels discovered by Weber. By S. Legouis.

The author indicates, in a few words, the history of our knowledge of supposed pancreatic structures in the osseous fishes, and shows that five years ago the pancreas had been recognized only in two species (*Silurus glanis* and *Esox lucius*), and supposed pancreatic granulations in about a dozen more. Weber noticed two systems of canals of very different appearance passing from the liver to the intestine in the carp, and imagined that the liver might furnish bile to one set and pancreatic juice to the other. This interpretation was rejected by C. Bernard, who, however, met with the double set of canals in other species.

The author commenced his researches in 1865; and he has examined 43 species, representing the principal families. He finds that Weber's canals exist in all the osseous fishes; they are invisible, like the middle lymphatics, in most species, but sometimes pearly (carp, turbot). They constantly open into the duodenum, near the gall-duct, and often by an ampulla. In some species with a convoluted intestine they acquire a very elegant arborescent form (barbel, grey mullet). Scarcely an intestinal sinus but receives some branchlet of this system; it passes among the pyloric appendages (dory, mackerel), associates its principal trunks with the *ductus choledochus*, the splenic and mesenteric veins, and the portal vein, which it follows into the mass of the liver.

All the osseous fishes possess a pancreas, however its elements may be dispersed, and the Plagiostomi have one similar in all respects to that of other Vertebrata. Among osseous fishes the author distinguishes the following three forms:—

1. *Disseminated pancreas.*—Glandular globules dispersed through the laminæ of the peritoneum (barbel, lumpfish, sardine, sand-smelt, loach, &c.).

2. *Diffused pancreas.*—In this the pancreas is lamellar, and resembles that of the rabbit, but forms a glandular web of very much greater tenuity. It is diffused throughout the interstices between the viscera, sometimes to such a degree (*Caranx*) that these are immersed in a pancreatic mass. The author refers to the following species among others as exhibiting this form of pancreas in various modifications:—conger, gurnard, *Sparus*, and stickleback.

3. *Massive pancreas*, resembling the organ in the higher Vertebrata (*Silurus*, pike, eel).

The three forms are associated, at least two and two. Weber's canals are the excretory ducts of the first two forms; and every one of their branches terminates in a gland. In many species the pancreatic and hepatic glands are still in progress when the fish is adult; this explains the apparent penetration of the pancreas into the liver.—*Comptes Rendus*, May 16, 1870, p. 1098.

On the Megadactylus polyzelus *of Hitchcock*. By E. D. Cope.

This genus was named by Hitchcock in his 'Supplement to the Ichnology of New England,' p. 39, 1865; the bones have been briefly described in his 'Ichnology,' on p. 186. The remains were found, in a more or less fragmentary condition, in the red-sandstone rocks of the valley of the Connecticut, from the neighbourhood of Springfield, Massachusetts. They were found by William Smith, while engaged in superintending some excavations made at the armoury, which required blasting.

The remains consist of four caudal and one dorsal vertebræ, the greater part of the left fore foot, with distal portions of the ulna and radius, the greater part of the left femur, proximal end of left tibia, greater part of left fibula, tarsus, and hind foot, including a tarsal bone, perfect metatarsus, proximal end of a second metatarsus, parts of the distal end of a third, and parts and impressions of four phalanges.

These fragments demonstrate the former existence in the region in question of a typical form of the suborder or order Symphypoda (*Compsognatha*, Huxley), and one nearer the birds than any other hitherto found in America. Its pertinence to this order is shown by the absence of the first series of tarsal bones, apparently (as Gegenbaur has suggested, and as the structure of *Lælaps* proves) in consequence of their confluence with the distal extremities of the tibia and fibula. This important character is apparently assumed early in life in the present genus and in *Compsognathus*, and probably quite late in *Ornithotarsus*. In *Compsognathus* the additional peculiarity of the persistence of but two carpal bones is presented, which, according to Gegenbaur, should correspond with those of the first row of ordinary Reptilia, while those of the second have disappeared. In *Megadactylus* those of the first series are present, viz. the radial and probably ulnar, and one of the second row, very much reduced, opposite to the second metacarpus; there is space for a second one of the second series, but it does not appear in the matrix, while the ulnar is probably lost.

The bird-like tendencies of the Symphypoda have been indicated above; and the very ornithic character of the bones of the present form is also very marked. The walls of the long bones are very thin; in some places near their extremities almost as thin as writing-paper. The vertebræ and ischia present the same thin walls; the structure of these walls is exceedingly dense.

Prof. Cope next gives the special characters of the bones, which are here omitted. He adds:—

That animals of this genus made some of the tracks similar to those of birds in the red sandstones of the valley of the Connecticut there can be no doubt. It furthermore explains some problematical impressions which are occasionally found with them. Tracks of an animal resting in a plantigrade position, as indicated by the moulds of two long parallel metatarsi, each terminated by three toes, are accompanied by a peculiar, bilobate, transversely oval mark on the middle line, some distance behind the heels.

Prof. Hitchcock states that it appears to be the impression of a short stiff tail. The present specimen shows clearly that it was made by the obtuse extremities of the ischia. The saurian squatted down, resting on its styloid ischia as the third leg of a tripod, of which the anterior pair was represented by the hinder legs. Prof. O. C. Marsh informs me that in the museum of Yale College a slab exhibiting impressions similar to the above shows the impressions of the anterior feet also, which were put to the ground in the act of rising or sitting, or perhaps reached to it while the animal was squatting, as do those of carnivorous Mammalia.

The tracks of many of the animals discovered by Hitchcock are plantigrade. That they could not have walked like the plantigrade mammal is sufficiently evident from the length of the metatarsal elements, which would necessitate a constant contraction of the tibialis anticus muscle, or a peculiar arrangement of the tarsal bones for its support. The latter does not appear to have existed; and the former is so very improbable that, in connexion with the pneumatic structure of the bones, there is abundant reason to suppose that they progressed by leaps, and assumed the plantigrade position when at rest.

No portion of the cranium or dentition of this genus has been preserved. The large stout hooked claws of the fore foot would indicate a more or less carnivorous diet.

The existence of Symphypoda in the strata here indicated, with the occurrence of a Pterosaurian in a similar situation in Pennsylvania, points to the existence of the transition from Keuper to Lias (that is, from Triassic to Jurassic beds) in the red sandstones of the eastern United States. They have been heretofore regarded as Triassic*, which the lower portions of them undoubtedly are, and similar to the German Keuper in the presence of Labyrinthodonts, Thecodonts, and Dinosauria in both Pennsylvania and N. Carolina.

The remains here described were alluded to by Prof. R. Owen as those of a Saurian pointing to the Pterodactyles or Birds, provided the cavities of the bones were filled with marrow, and not with cartilage. Prof. Wyman regarded them as those of a reptile, though the long bones might have been referred to a bird, if considered alone. "While the bones from Springfield are as hollow as those of the Pterodactyle, I do not find that they are those of this animal; there is no positive proof of the long fingers, nor of the broad sternum, which these reptiles possessed. The existence of the large toe in company with the small one is in favour of a jumping animal."—*From the Memoir of Prof. Cope on Extinct Reptilia and Aves, Amer. Phil. Soc., unpublished volume.—Silliman's American Journal,* May 1870.

* Hitchcock, in his 'Ichnology' (1858), holds that the beds containing the tracks are Lower Jurassic, either Oolitic or Lias; and Dana, in his 'Geology' (pp. 414, 443), says that the so-called Triassic is probably in part Jurassic.—Eds. Am. Journ. Sci.

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END OF THE FIFTH VOLUME.

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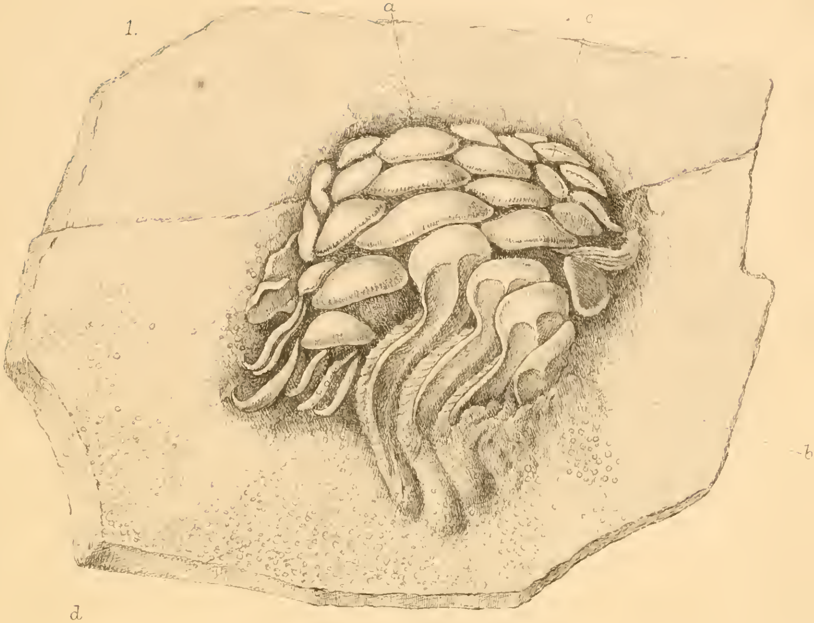

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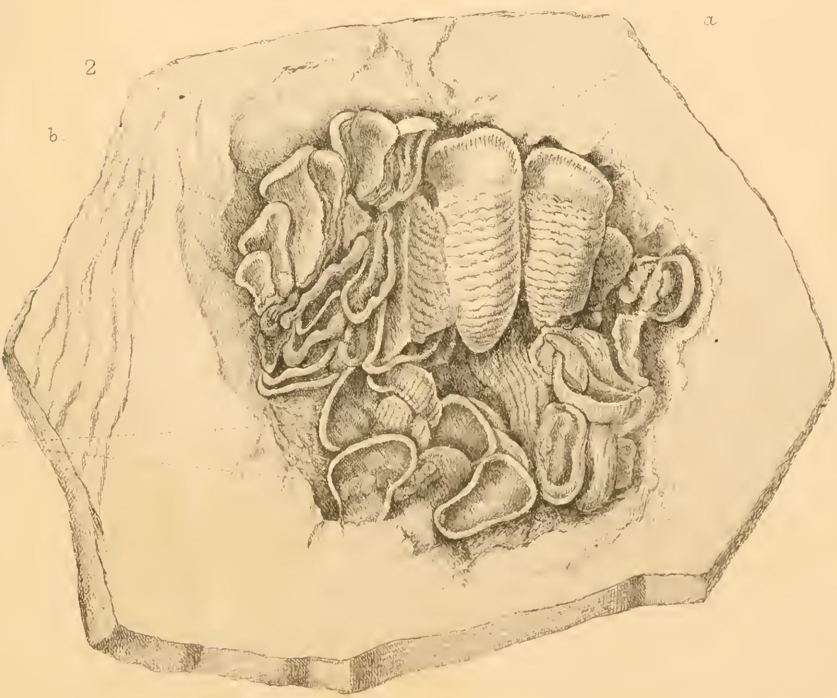

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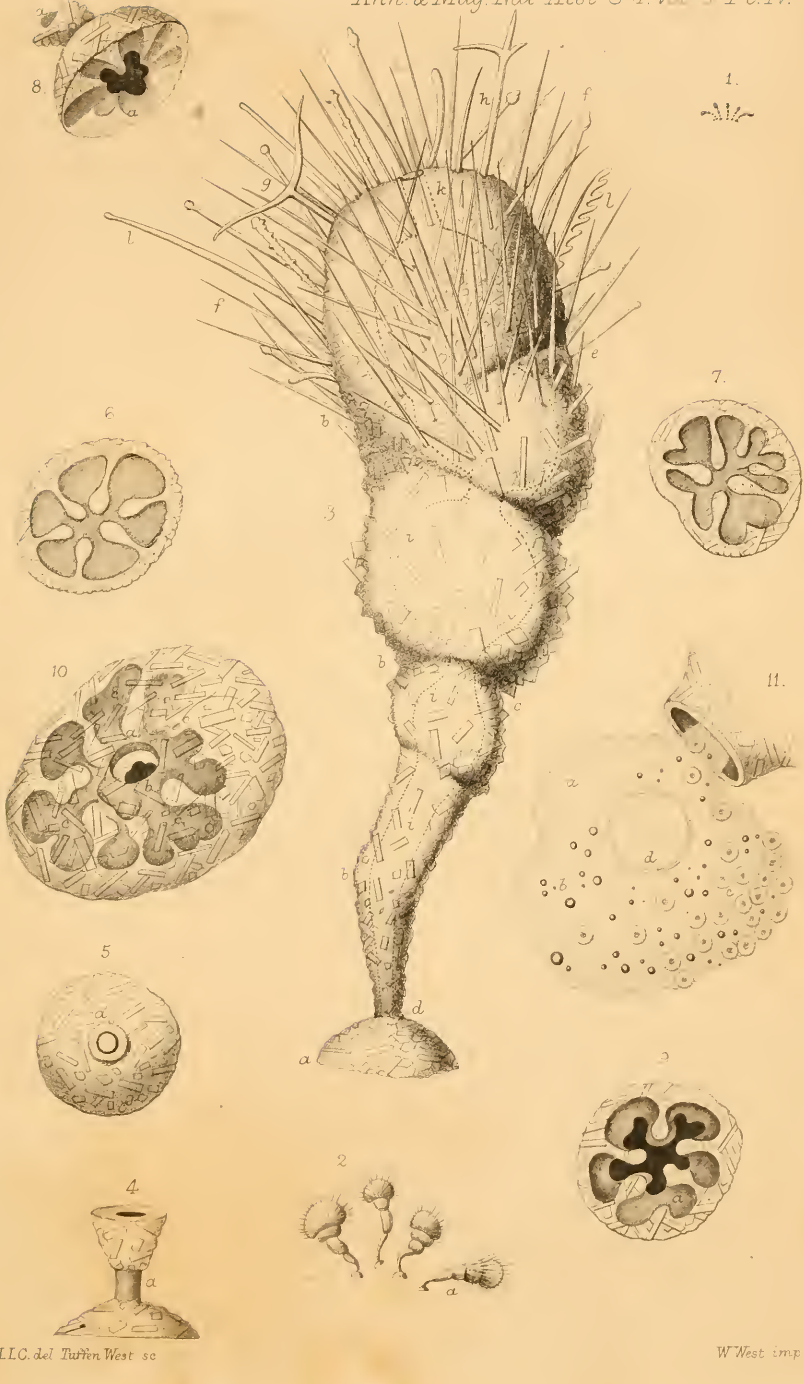

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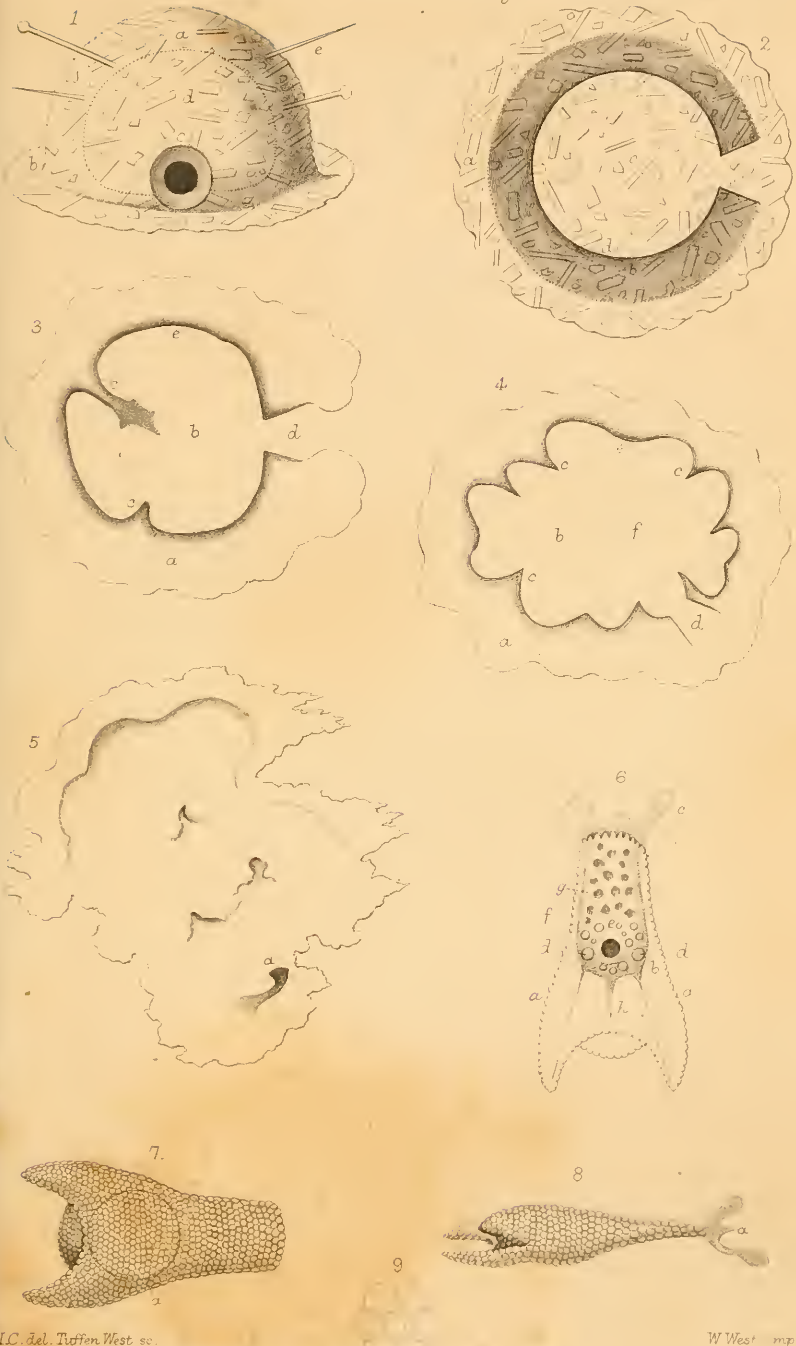

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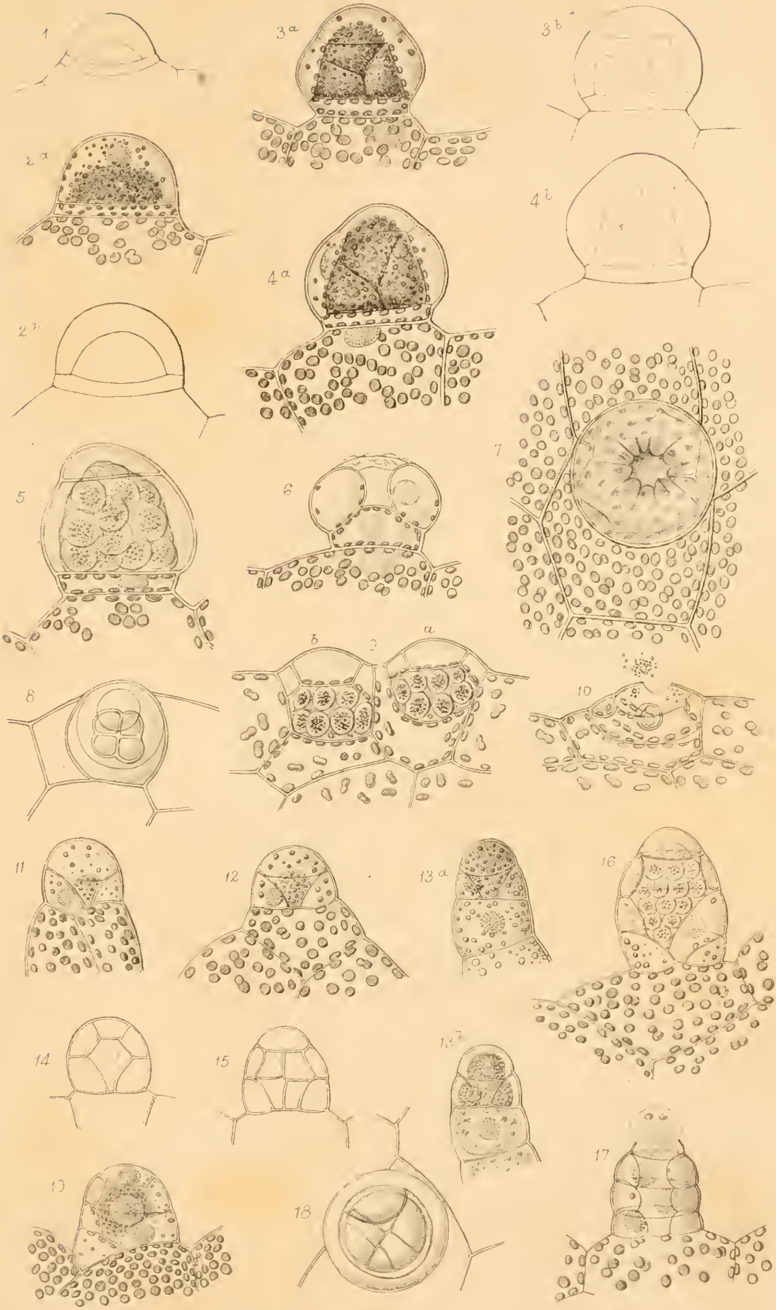
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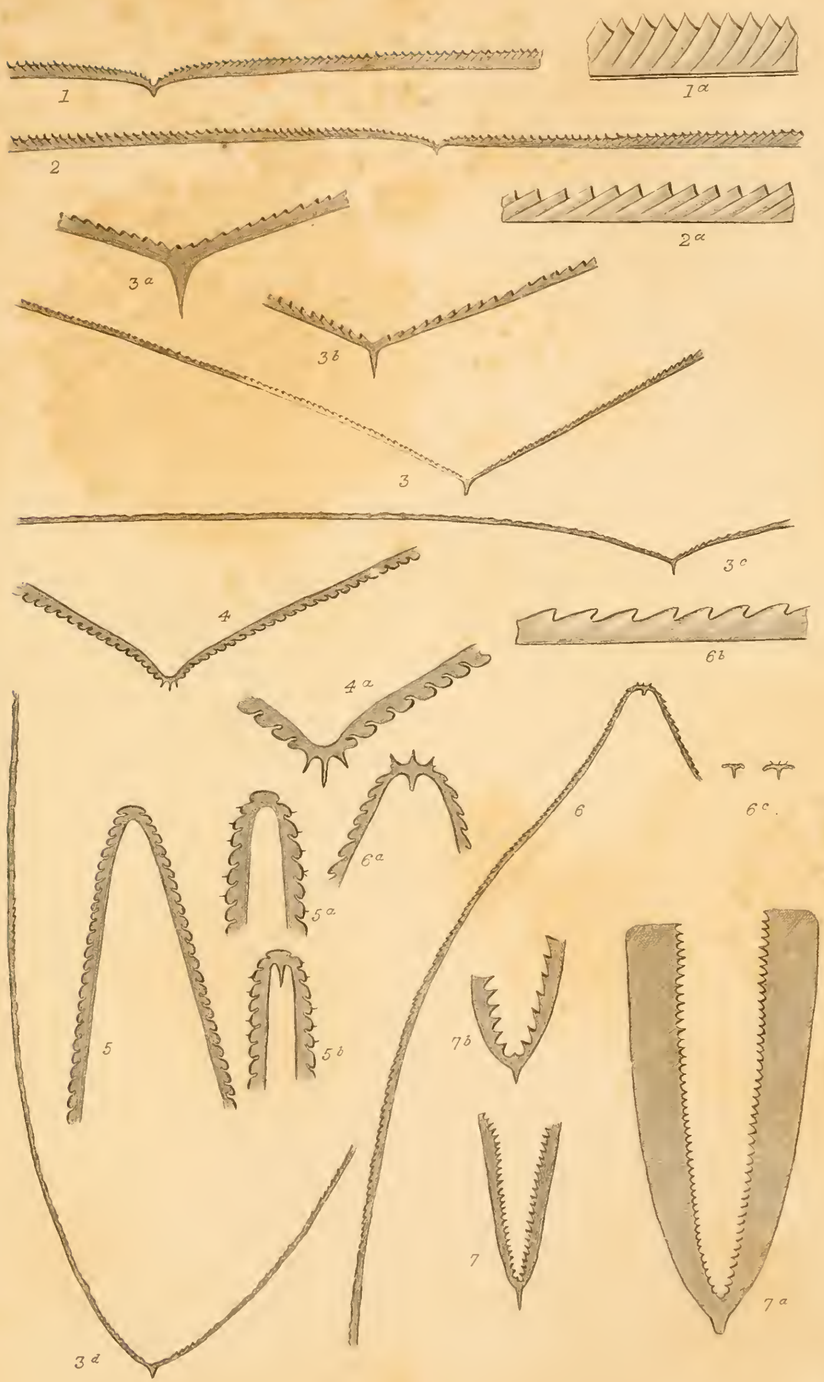
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