

## 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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VOL. XV.—FOURTH SERIES.  
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LONDON:

PRINTED AND PUBLISHED BY TAYLOR AND FRANCIS.

SOLD BY LONGMANS, GREEN, READER, AND DYER; SIMPKIN, MARSHALL,  
AND CO.; KENT AND CO.; WHITTAKER AND CO.: BAILLIÈRE, PARIS:  
MACLACHLAN AND STEWART, EDINBURGH:  
HODGES, FOSTER, AND CO., DUBLIN: AND ASHER, BERLIN.

1875.

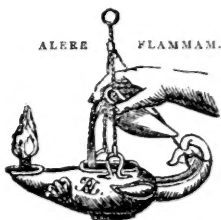
"Omnes res creatæ sunt divinæ sapientiæ et potentiæ testes, divitiæ felicitatis humanæ:—ex harum usu *bonitas* Creatoris; ex pulchritudine *sapientia* Domini; ex œconomiâ in conservatione, proportione, renovatione, *potentia* majestatis elucet. Earum itaque indagatio ab hominibus sibi relictis semper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

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# THE ANNALS

AND

## MAGAZINE OF NATURAL HISTORY.

[FOURTH SERIES.]

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“..... per litora spargite muscum,  
Naiades, et circum vitreos considite fontes:  
Pollice virgineo teneros hic 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.

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No. 85. JANUARY 1875.

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I.—*Observations on Hæckel's Gastræa Theory.*  
By Dr. W. SALENSKY\*.

[Plate V.]

HÆCKEL'S investigations on the Calcispongiæ, which are brought together in his admirable monograph, have led him to a theory to which he ascribes great importance for the conception of the phylogenetic relations of the types of animals, and which he calls the *Gastræa* theory. This theory was first presented in its chief features in the portion of the monograph treating of developmental history; but Hæckel has since published a special memoir upon it and expounded it much more in detail and with relation to the germ-lamella theory †.

In its principal features this theory may be summed up very shortly. It consists chiefly in the statement that in the ontogenetic development of all the representatives of the vari-

\* Translated by W. S. Dallas, F.L.S., from the 'Archiv für Naturgeschichte,' 1874, pp. 137-174.

† Hæckel, 'Die Gastræa-Theorie, die phylogenetische Classification und die Homologie der Keimblätter.'

ous types of animals an embryonal form occurs which possesses an elongate-oval shape, consists of two layers (exoderm and entoderm), and encloses a cavity, the stomachal cavity. Häckel discovered a larva of this construction in the Calcispongiæ and called it the "*Gastrula*."

"From the identity of the *Gastrula* in representatives of the most different types of animals, from the Sponges to the Vertebrata," Häckel deduces, "in accordance with the biogenetic fundamental law, a common descent of the animal phyla from a single unknown stock-form, constructed essentially in the same way as the *Gastrula*: the *Gastræa*"\*.

In the monograph of the Calcispongiæ, however, Häckel adduces but few facts in evidence of his theory. He indicates only a few animals in which, in his opinion, this form occurs in the cycle of embryonal forms. It would naturally be expected that in the memoir subsequently published and specially devoted to this theory such facts would be carefully cited; but this is by no means the case. All that he has done for the factual establishment of the *Gastræa* theory is that he gives eight partially diagrammatic figures, and, in the case of certain types, mentions some animals in which the *Gastrula*-stage is supposed to occur (see 'Die Kalkschwämme,' Band i. p. 467, and 'Die Gastræa-Theorie,' p. 18). The new additions to the facts indicated in the monograph of the Calcispongiæ relate to various types of animals. According to the monograph, among the Vermes the *Gastrula*-stage occurs in *Phoronis*, *Sagitta*, *Euaxes*, *Ascidia*, &c., and according to the "*Gastræa*-Theorie" in the Platyelmintha (*Turbellaria* and *Trematoda*), the Nematelmia (*Nematoda*, *Sagitta*), in the Bryozoa and Tunicata, in the Gephyrea and Annelida (*Phoronis*, *Euaxes*, *Lumbricus*, *Chætopoda*). Of the Echinodermata, Häckel, in the "*Gastræa*-Theorie," cites, besides the Asterida, the Holothurida. Of the Arthropoda he says, in the monograph, "Embryonal forms which are easily derivable from the *Gastrula* occur also among the Arthropoda" (Crustacea and Tracheata). In the "*Gastræa*-Theorie" he gives the figure of a *Gastrula* deduced from the earliest developmental form of the *Nauplius*. In the Mollusca, the *Gastrula* is confined, in the monograph only, to the development of *Limnæus*; in the "*Gastræa*-Theorie" the *Gastrula* appears "to be widely diffused in the classes of Bivalves and Univalves." Among the Vertebrata Häckel cites only *Amphioxus* in both works, although he remarks that "the continuity which exists between the ontogeny of *Amphioxus* and the other Vertebrata leaves no

\* Die Kalkschwämme, Band i. p. 467.

room to doubt that the ancestors of the latter also, at earlier periods of the earth's history, passed through the *Gastrula* in the commencement of their ontogenesis." Of course this cannot be proved by facts.

If the theory be correct it must be in accordance with the facts and explain them. If it is of so much significance in the elucidation of the phylogenetic connexion of animals, we must expect:—1. That the *Gastrula*-stage should actually occur very frequently in the ontogenetic development of animals; or if it is not of such general occurrence (for example, if it is over-leaped in the ontogeny of certain animals) some of the consequent phenomena and the analogies in the development of different animals must at once show us that this stage really formerly existed and has merely been overleaped. 2. If the theory is of so much significance for the elucidation of the true interpretation of the ontogenetic import, the development of those animals in which the *Gastrula*-stage does not occur as such must be deduced and elucidated from this; for the importance of the *Gastræa* theory is by no means proved only by our detecting the *Gastrula*-stage in some representatives of the different types of animals. What is required of the *Gastræa* theory must therefore consist (1) in the actual proof of the occurrence of the *Gastrula*-stage in the ontogeny of different animals, and (2) in the actual proof of its significance in the explanation of the ontogenetic phenomena. If this were the case, all complicated phenomena with which we are acquainted by observation must find a much better explanation in this theory than in previous conceptions.

Let us turn first to the facts which, according to Hæckel, demonstrate the occurrence of the *Gastrula*-stage in different animal types.

### I. *Factual demonstration of the Gastræa theory.*

The *Gastræa* is defined by Hæckel in the following words:—"The *Gastræa* is a spherical or elliptical body, with a stomachal cavity and a mouth-opening, the stomach-wall of which is formed by *two different cell-layers*, the inner, non-vibratile gastral lamella or entoderm, and the exterior, vibratile dermal lamella or exoderm." This definition is so clear and distinct that we may at once recognize the *Gastrula*-stage if it exists in the ontogeny of an animal.

Let us commence our revision of embryological facts with the ontogeny of the Cœlenterata. That in these the *Gastrula*-stage is remarkably widely diffused and plays a very important part follows *à priori* from the fact that the Cœlenterata

(hydroid polyps, sponges), even in their developed state, diverge very little from the *Gastræa* form. But even in this animal type the Ctenophora are distinguished from the other Cœlenterata by some very important embryological phenomena, since in them, according to the well-known investigations of Kowalevsky\*, the gastrovascular system is first produced from the exoderm in the form of a solid cellular cord or of a cylinder, which only acquires a cavity at a later period, after the meridional rings are indicated. The very important objection which this case offers to the *Gastræa* theory consists in the fact that it cannot be referred to either of the two modes of development of the *Gastrula* indicated by Hæckel, and that here no *Gastrula*-stage exists.

*Vermes.*—"In the stock of the Vermes the *Gastrula* (the so-called 'infusoriiform embryo') occurs sometimes in exactly the same, sometimes in a more or less modified form in the Platyelmintha (Turbellaria and Trematoda), in the Nematelmia (Nematoda, *Sagitta*), and in the Bryozoa, Gephyrea, and Annelida (*Phoronis*, *Euaxes*, *Lumbricus*, Chaetopoda)."

From the fact that embryos of very different organization are comprised under the so-called "infusoriiform embryos," we may assert *à priori* that these embryos are like the *Gastrula* in some cases and different from it in others. Such differences often occur between the embryos of one and the same class of Vermes, as, for example, between the various Trematoda. In some of the digenous Trematoda, the mouth and intestine have been demonstrated in the embryonic state; in others (and indeed in the majority) they have not. In the subsequent stages of development, as is well-known, the redia are distinguished from the sporocysts by these characters †. The development of the monogenous Trematoda is so little known that we are not at present in a position to say, from the ascertained facts, whether or not a stage resembling the *Gastræa* occurs in these animals. The most complete investigations in this direction, namely those of E. van Beneden ‡, Zeller §, and Willemoes-Suhm ||, furnish so little information as to the embryonic history of these Trematoda, that we only learn from them the fact that the animals on escaping from the egg already possess all their organs (except the sexual organs).

\* Mém. de l'Acad. Imp. de St. Pétersb. tom. x.

† Leuckart, 'Die menschlichen Parasiten,' Bd. i. p. 491.

‡ "Recherches sur la composition et la signification de l'œuf," Mémoires couronnés de l'Acad. Roy. de Belg. tom. xxxiv.

§ *Ibidem.*

|| Zeitschrift für wiss. Zoologie, Bd. xxii.

Of the embryonic development of the Turbellaria also we know very little; and what we do know does not prove that these animals pass through a *Gastrula*-stage. As far as I know, there exist only two investigations which show thoroughly and in detail the embryology and especially the production of the organs, of the Turbellaria. In the memoir of E. van Beneden (*Recherches &c.*) the process of segmentation is chiefly considered. The two other investigations are due to Keferstein\* and Knappert †. According to the last author the vitelline mass undergoes segmentation and then separates into a central and a peripheral layer, of which the latter, by repeated division, furnishes an animal lamella, which becomes converted into the body-wall with the muscular layer and epithelia, and a vegetative lamella, which is developed into the intestinal membrane. There is little in this memoir upon the production of the buccal orifice and intestinal cavity. Keferstein's investigations agree pretty nearly with those of Knappert, as he also represents the body-wall and the intestinal wall as produced by the division of a layer, the upper layer. It seems to me, however, that in the Turbellaria we may with great certainty assume the *Gastrula*-stage, because in the sexually immature state they differ very little in their organization from the *Gastrula* type.

It is otherwise with Nemertina, in which, by the remarkable investigations of Mecznicoff ‡, the earliest developmental processes have been elucidated. From these interesting researches we learn the important fact that the larva is excluded in the form of a vesicle of one layer and that it leads a free life. According to Mecznicoff a vesicle of one layer is first produced from the egg of the Nemertian; this becomes covered with cilia and then escapes from the egg. This vesicle then undergoes an introversion, which subsequently becomes differentiated into two parts, the anterior intestine and the stomach. Here, therefore, we have a *Gastrula*-stage. The Nemertina, however, must be separated from the other Turbellaria, as they must be referred to the Cœlomati, and the others to the Acœlomi.

Whether a *Gastrula* form exists in the ontogeny of the Nematoda is not yet proved. From the researches of Leuckart §

\* Beiträge zur Anatomie und Entwicklungsgeschichte einiger Seeplanarien von St. Malo, 1868.

† "Embryogénie des Planaires d'eau douce," Archives Néerlandaises des Sci. &c. This memoir is known to me only by the reports of Keferstein and Leuckart.

‡ Mém. de l'Acad. Imp. de St. Pétersb. tome xiii.

§ Leuckart, 'Die menschlichen Parasiten,' Bd. ii. Lief. 1, p. 93. E. van Beneden (*Recherches, &c.* p. 102) regards the interior opaque mass of the embryo as nutritive vitellus; but this appears to me to be by no means proved.

we may suppose such a stage to occur in *Strongylus filaria* and *Cucullanus*. In all Nematoda an embryo consisting of two layers is formed after the conclusion of the process of segmentation. From the outer layer is formed the body-wall, from the inner one the intestine. The production of the intestinal cavity occurs at the time of the formation of the body-cavity.

The researches of Kowalevsky on the embryology of *Sagitta*\* establish beyond doubt that in the embryology of this worm we may admit a *Gastrula*-stage.

The statements of Hückel that a *Gastrula*-stage occurs in the Bryozoa do not agree with the known investigations. From the researches of Nitsche†, Claparède‡, and Mecznikoff we know that at any rate in the *Bicellariæ* (*Bugula*) no stomachal cavity is formed in the larva. As to the embryonic development of the *Cyphonautes*-like larvæ, which, as is well-known, possess an intestinal canal, we have no information. In the postembryonic developmental history of the Bryozoa, which has been better investigated than their embryonic development, we find no state which has any resemblance to the *Gastrula*-stage. It is well known that here the intestinal canal (polypide) is developed in a very different manner from other animals.

In the class Gephyrea, if *Phoronis* is to be referred to it, a *Gastrula*-stage occurs in that worm.

Hückel's statement that *Euaxes* in its ontogeny passes through a *Gastrula*-stage, is decidedly not correct. The remarkable investigations of Kowalevsky, upon which Hückel depends, best prove this. From the embryology of the Oligochæta we learn that cases may occur in which, in the same group of animals, one animal passes through a decided *Gastrula*-stage in its ontogeny, while another does not. This fact alone sufficiently proves that, in the demonstration of the *Gastræa* theory, we can by no means be contented with a few representatives of the animal types. The two Oligochæta which Kowalevsky has selected as the subject of his researches, *Euaxes* and *Lumbricus* (the ontogeny of *Tubifex* is like that of *Euaxes*) show very essential differences in their first embryonic stages. In *Euaxes* the segmentation takes place in the way which is so characteristic of some Vermes and Mollusca. After the first cell-division four large spheres of segmentation are formed, upon which a great quantity of smaller

\* "Embryologische Studien an Würmern und Arthropoden," in Mém. de l'Acad. Imp. de St. Pétersb. tome xvi.

† Zeitschr. für wiss. Zool. Bd. xx.

‡ *Ibid.* Bd. xxi.



ones soon make their appearance. The former afterwards form the entoderm, the latter the dermal lamella. Between these two foundations of the germ-lamellæ a third layer of cells is immediately produced, and this forms the middle germ-lamella. From this it follows that in *Euaxes* there is no stage which has any resemblance to the *Gastræa*, and, indeed, that no such stage can occur, because the *Gastrula* should consist only of two layers. But here, even before the conclusion of the process of segmentation, all three germ-lamellæ are founded. In *Lumbricus*, however, which is systematically very nearly allied to *Euaxes*, a *Gastrula*-stage occurs.

In the ontogeny of the Chætopoda there seems to be no *Gastrula*-stage. From the investigations of Claparède and Mecznikoff\* it appears that, after the segmentation of the egg in the Chætopoda, an embryo consisting of two germ-lamellæ is formed, and that this soon acquires the bands or tufts of cilia &c. and then quits the egg without possessing any stomachal cavity. Then the eyes are formed in the embryo, the segments of the body become differentiated, and finally the stomachal cavity with mouth and anus is produced. The latter consequently takes place long after the time when the embryo already possesses its larval organs (*Spio fuliginosus*, *Lumbriconereis* sp., and *Dasychone lucullana*).

I need hardly mention that the *Ascidia* pass through a *Gastrula*-stage in their ontogeny. This is fully proved by the well-known researches of Kowalevsky.

According to this examination of the stock Vermes, we can with certainty detect the *Gastrula*-stage only in *Sagitta*, *Phoronis*, *Lumbricus*, the *Ascidia*, and the *Nemertina*. In the other Vermes the existence of the *Gastrula*-stage is by no means proved by embryological researches. We have seen that it does not occur in the ontogeny of most Trematoda, and probably of most Nematoda, Bryozoa, *Euaxes*, and the Chætopoda. Perhaps the Leeches might be added to the Vermes which pass through a *Gastrula*-stage (Leuckart, 'Die menschlichen Parasiten,' Bd. i. p. 689).

Before we pass to the other types of animals, we must refer to an important phenomenon which is of much significance in the correct estimation of the factual evidence. The mode of formation of the buccal aperture and of the anterior part of the intestinal canal must be mentioned, as in it phenomena occur which might lead to the assumption of a *Gastrula*-stage in cases in which really no such stage exists. In the ontogeny of all animals (except the Sponges and some

\* "Beiträge zur Erkenntniss der Entwicklungsgeschichte der Chætopoden," Zeitschr. für wiss. Zool. Bd. xix. pp. 169, 182, and 197.

Cœlenterata and Vermes) the buccal aperture originates as an invagination of the upper germ-lamella, and, indeed, first of all in the form of a little tube closed posteriorly, which only opens into the subsequently formed intestinal cavity at a very late period (in many, if not in all cases, after the formation of the anus). I mention this only because this buccal invagination may in some cases be confounded with the invagination of the superior germ-lamella of *Amphioxus*, the Ascidia, and other animals, which leads to the formation of the stomachal cavity. The two processes, however, are essentially different. The invagination in *Amphioxus* and others is a process by which the two germ-lamellæ acquire a definite form and position and the intestinal cavity is formed; at the time of that invagination which leads to the formation of the anterior intestine and buccal aperture, on the contrary, the two germ-lamellæ have already long attained to their form and position, and by this latter invagination only the anterior intestine (œsophagus, gizzard, &c.) is formed. Undoubtedly Hæckel has this circumstance in his mind when he says that the buccal apertures of the Vertebrata, Arthropoda, and Echinodermata (to which the Mollusca may be added) are peculiar new formations and certainly not homologous with the primitive mouth. The confusion appears to me, however, to have been made by Ray Lankester\* when, in speaking of the developmental history of the Nudibranchiata, he says, "and its occurrence (*i. e.* the invagination or in-pushing of cells at one pole, just as Kowalevsky has drawn it in *Amphioxus* and *Phallusia*) in a similar stage in certain marine Lamellibranchs is clear from Lovén's admirable figures, though he has mistaken its significance." According to the statements of Lovén and the figures given with his researches we see at once that in the Lamellibranchiata investigated by him the buccal aperture and anterior intestine are formed by invagination; and therefore these invaginations cannot be compared to those which were described by Kowalevsky. To make the circumstances clear I give figures (Pl. V. figs. 1-3) of three stages in the development of the oyster which are characteristic in this respect.

As regards the Echinoderms we must conclude, from the beautiful investigations of Agassiz †, Meeuwikoff ‡, and Kowalevsky §, that the *Gastrula*-stage is very prevalent in the developmental history of these animals.

"In the stock of the Arthropoda the *Gastrula* is indeed nowhere any longer preserved in its original pure form; but it is

\* *Annals & Mag. Nat. Hist.*, February 1873.

† *Contrib. to the Nat. Hist. of the United States*, vol. v.

‡ *Mém. de l'Acad. de St. Pétersb.* tome xiii.

§ *Ibid.* tome xi.

very easy to reduce the earliest developmental forms of the *Nauplius* (as the common stock-form of the Crustacea) and of many other Tracheata to the *Gastrula* \*\*\*. In this connexion H $\ddot{u}$ ckel refers to the ontogenetic works of E. van Beneden and Bessels and to the writings of Weissmann. The comparison of the earlier developmental stages of the *Nauplius* with the larv $\ddot{e}$  of Annelids has been carried out by E. van Beneden in his investigations of the development of *Anchorella*, *Branchiella*, and *Hessia*. Unfortunately I have been unable to procure this work, which is known to me only by Nitsche's reports. From the embryological facts known to me with regard to the developmental history of the Arthropoda, and with these also the statements of E. van Beneden upon the development of the above-mentioned Crustacea, there is no indication of the existence of the *Gastrula*-stage in the ontogeny of these animals. The developmental processes of the lower Crustacea, and, indeed, of the Arthropoda in general, agree with those of the Annelida in this respect, that the first stage after the completion of the process of segmentation in the representatives of these two animal types constitutes a body which consists of two layers but possesses no cavity in its interior. The subsequent phenomena are as follows: in the Annelida, as in the Crustacea, the organs of motion appear on the surface of an embryo thus constructed—in the former the rows of cilia, in the latter the limbs; then the mouth and anus are invaginated, and finally the intestinal cavity is formed. We have noticed the same series of developmental phenomena in the Chaetopoda. Exactly the same series has been demonstrated in the various Arthropoda; and this may be proved especially by the investigations which go in some detail into the history of the formation of the internal organs. With respect to the *Nauplius* it is proved by the researches of E. van Beneden and Bessels†, and especially by the figures to the developmental history of *Anchorella uncinata* and *Clivella hippoglossi*, and also by my own researches ‡ upon the development of *Sphaeronella Leuckarti*. With regard to the higher Crustacea it may also be regarded as demonstrated by the investigations of E. van Beneden and Bessels (ibid., *Gammarus locusta*, where a stage is figured pl. ii. fig. 6 at the commencement of the formation of the tail), by A. Dohrn § (*Asellus aquaticus*), by Mecznikoff || (*Nebalia*), and by Bobretzky ¶ (*Astacus fluviatilis*, *Pal $\grave{e}$ mon*).

\* H $\ddot{u}$ ckel, *loc. cit.*

† M $\acute{e}$ moires couronn $\acute{e}$ s de l'Acad. Roy. de Belg. tome xxvi.

‡ Archiv f $\ddot{u}$ r Naturg. 1869.

§ Zeitschr. f $\ddot{u}$ r wiss. Zool. Band xvii.

|| Zapiski Imperatorskoi Akademii Nauk, 1869.

¶ Zapiski Kievskago Obshestva Estestvoisitatelei, 1873.

“In the stock of the Mollusca the *Gastrula* seems to be widely prevalent, especially in the classes Conchifera and Gasteropoda, and probably also in the Spirobranchiata; among the Gasteropoda it was first observed in *Limnæus*”\*. In proof of this statement Häckel appeals to the memoir by Ray Lankester (Ann. & Mag. Nat. Hist., February 1873, pp. 86, 87). As regards the observations of Ray Lankester on *Aplysia*, which are described in most detail, we cannot see there a *Gastrula*-stage, as, according to the statements of that naturalist, the external organs (mantle &c.) make their appearance very early, and it is not stated when the stomachal cavity appears. And as regards the other Mollusca, *Doris*, *Tethys*, *Pleurobranchus*, *Polycera quadrilineata*, and *Eolis exigua*, which are also briefly referred to by Ray Lankester, it must be admitted that these few words, “I was able to determine in these that the first step in development, after the formation by cleavage of the mass of embryo-cells or ‘polyblast,’ is the invagination or in-pushing of these cells at one pole, just as Kowalevsky has drawn it in *Amphioxus* and *Phallusia*, and as seen also in the heteropod mollusk *Atalanta*,” do not prove very much. These statements are supported neither by figures nor by a detailed description of the observed facts. I am far from doubting the correctness of Ray Lankester’s statements, and indeed cannot do so, because we already know many cases in which in animals systematically nearly related the invagination (and, indeed, the *Gastrula*-stage) occurs in some and not in others (*e. g.* *Euaxes* and *Lumbricus*). But for me they have too little force as evidence to enable us to rest the existence of the *Gastrula*-stage in the Mollusca upon them. It is the more necessary to describe such observations in detail, because, with respect to the developmental history of the Mollusca, there exists a mass of statements which are mutually very contradictory. With regard to the Lamellibranchiata the statements of different naturalists are tolerably concordant. For the greater part of the observations we are indebted to the remarkable, although already old, investigations of Lovén, which give the most complete picture of the development of several marine bivalves. From these observations and the figures accompanying them we see that the first stage of the development is an embryo which consists of two layers and has no cavity in its interior, that then various external organs and a buccal invagination are formed, and finally an intestinal cavity is produced in the interior of the entoderm. The phenomena are closely in accordance with what we have already had occasion to mention in other animals. They are

\* Häckel, ‘Gastræa-Theorie.’

elucidated by the three figures already given (Pl. V. figs. 1-3), which represent three characteristic developmental phases of the oyster.

But as regards the Cephalophora, the greater part of the observations on this class of the Mollusca agree in showing that, after the segmentation, the egg of these animals becomes converted into a body which consists of two different elements—namely, coarsely granular, which lie in the interior of the embryo, and paler, which surround the preceding. Such developmental stages have been demonstrated in the Pteropoda (*Tiedemannia* and *Cavolinia*) and Heteropoda (*Pterotrachea coronata*) by the very complete and remarkable observations of Gegenbaur\*; the same conditions are presented, according to J. Müller †, by *Entoconcha mirabilis*; and *Dentalium* has a similar development, according to Lacaze-Duthiers ‡. I have myself described the same *Planula*-stage occurring first after segmentation in the Prosobranchiata (*Calyptrea*, *Nassa*, and *Trochus* §). In all the animals mentioned also the subsequent phenomena occur in a nearly concordant manner. First the organs of locomotion are formed, then the foot; the mouth and œsophagus are invaginated, and finally the intestine is formed.

*Ampullaria* (according to Semper), *Ancylus* (according to Stephanoff), and *Limnæus* (according to Lereboullet) are developed somewhat differently from these Mollusca. If we compare the statements of these last-mentioned naturalists, we arrive at the conviction that the *Gastrula*-stage occurs only in the ontogeny of *Limnæus*, according to the observations of Lereboullet ¶. But these observations are opposed by the very recent beautiful observations of Ganin ¶¶ (which unfortunately are published without figures). From these last it appears that the invagination of *Limnæus* does not correspond to those of *Amphioxus*, the *Ascidia*, &c., but is rather homologous with the invagination of embryos of *Calyptrea*, which in *Calyptrea* separates from each other the rudiments of the vela, foot, and cephalic vesicle. At the bottom of this invagination, in *Limnæus* as in *Calyptrea*, the œsophageal invagination is formed.

In the Cephalopoda there can certainly be no question of a *Gastrula*-stage.

\* Untersuchungen über die Pteropoden und Heteropoden.

† Ueber *Synapta digitata*, und über die Erzeugung der Schnecken in Holothurien.

‡ Memoirs in Ann. des Sci. Nat. 1854-57.

§ Zeitschr. für wiss. Zool. Bd. xxii.

¶ Recherches sur le développement de la truite, du lézard et de la limnée.

¶¶ Warschauer Universitäts-Nachrichten; also Nitsche's Reports, 1872.

In the stock of the Vertebrata a *Gastrula*-stage occurs only in *Amphioxus lanceolatus*.

From this brief summary we may conclude that the diffusion of the *Gastrula*-stage in the ontogeny of animals is limited to the following—the Cœlenterata (with the exception of the Ctenophora), the Echinodermata, probably some Nemertina, *Lumbricus*, *Sagitta*, the Ascidia, perhaps some Mollusca (?), and *Amphioxus lanceolatus*.

## II. *The significance of the Gastrula-stage.*

Having shown, in the preceding section, that the *Gastrula*-stage is not so generally diffused in the ontogeny of animals as Hæckel asserts, we have already in part furnished evidence that its importance in ontogeny is not so great as Hæckel states. Nevertheless it may be very justly objected to this notion that, although the *Gastrula* is not of such general occurrence, it may yet, as a stock-form, play an important part in the elucidation of the phylogenetic relations of animals. The *Gastrula*-stage might be overleaped in some animals, or obscured by some secondary ontogenetic phenomena. We ought then to recognize this overleaping of the *Gastrula*-stage from some other embryonal phenomenon. The *Nauplius*-stage, which may with perfect justice be regarded as the stock-form of the Crustacea, may be seen in the most different orders of that class; in the most diverse representatives of these orders we may, with the greatest certainty, derive from this stage the further changes, the progressions and retrogressions of development. Such are the requirements that we must lay upon the *Gastrula*-stage if we are to regard the *Gastræa* as the stock-form of the Metazoa. We ought therefore to recognize its occurrence in many animals, and be able to read in the development of the animals the history of gradual changes from this stock-form. This, however, we cannot in reality do. We know no single case in which, the *Gastrula*-stage being wanting, the later embryonal phenomena can be elucidated by it; we do not even know of any instance in which the primitive intestine is replaced by a later one. On the contrary we always see that, in those cases in which the *Gastrula*-stage occurs, this primitive intestine becomes transformed into the permanent intestine, and the primitive mouth remains in these forms (except in *Sagitta*) as the permanent mouth. Why are we to characterize this intestinal cavity as the primitive intestine, when in no instance can we see a secondary intestine? But in those cases in which we cannot detect any *Gastrula*-stage (*e. g.* in the Arthropoda, Mollusca, most Vermes, &c.) we witness the

production of the intestine at a much later stage, when several germ-lamellæ already exist, and the embryo already possesses the characteristic organs of its type, or at least their foundations. Why are we in these last cases to assume the *Gastrula*-stage, when we can discover no traces of any thing of the kind? This could aid us in the comprehension of the developmental processes only if we could derive these instances of the later formation of the intestinal cavity through a series of transitions from the stage which possessed a primitive intestine and had two germ-lamellæ—that is to say, from the *Gastrula*. But we can trace this gradual differentiation *only* in the animals which pass through a true *Gastrula*-stage (*e. g.* *Amphioxus*, the *Ascidia*, &c.). In most others we cannot bring the embryonal processes into connexion with the *Gastrula*, we cannot regard them as dependent upon the *Gastræa* (in many *Vermes*, *Mollusca*, *Arthropoda*, and most *Vertebrata*). This shows at once that the *Gastrula*-stage is proper only to a few animals, and does not occur in the others; and these other animals pass through their embryonal development, their subsequent differentiation of the intestine, in a somewhat different manner from the former. Can such a form be regarded as the stock-form of all the *Metazoa*? At least we have no facts in proof of this assertion.

On theoretical grounds we cannot expect to find the *Gastrula*-stage universally diffused:—in the first place because the intestinal cavity is developed in different animals at different periods of their development; but this intestine is the same as the intestine of those animals which have a *Gastrula*-stage, and yet it is not bound to a definite stage, *i. e.* to definite temporary conditions of the embryo (as, for example, the existence of two primary germ-lamellæ). Secondly, we cannot expect the *Gastrula*-stage to be universally diffused, because there are animals which never arrive at the development of an intestinal cavity. I do not refer to the parasites which have lost their intestinal cavity in consequence of retrogressive metamorphosis, although this loss cannot be regarded as ontogenetically proved in all parasites (*e. g.* in the *Cestodea*). I refer to the acelous *Turbellaria*, which live under the same conditions as the *Rhabdocæla* and *Dendrocæla*, which move in the same manner as these and yet possess no intestine. Ulianin has with perfect justice separated them from the others as *Acæla* \*. Instead of the intestine these *Turbellaria* have a

\* Such as *Convoluta*, *Schizoprora*, *Nadina*, &c. See O. Schmidt, "Untersuchungen über Turbellarien von Corfu und Cephalonien" (*Zeitschr. für wiss. Zool.* Bd. xi.); Claparède, 'Beobachtungen über Anatomie und Entw. wirbelloser Thiere'; and especially Ulianin, 'Turbellaria of the Black Sea' (in Russian).

sarcode-like body-mass, into which various small organisms find their way as nourishment and are there digested in the same way as in the Infusoria. They have consequently a mouth and the intestinal foundation (*Darmanlage*), but are destitute of the stomachal cavity. We have no grounds for explaining the absence of the intestinal cavity in these animals as a consequence of retrogressive metamorphosis\*.

These two circumstances (namely, 1, the diversity of organization of the embryos of different animals at the time of the formation of the intestinal cavity, and, 2, the acœlous condition of some Turbellaria) show quite sufficiently that we are not in a position to derive the embryonal processes from the *Gastrula*, nor consequently to accept the *Gastræa* as the stock-form for the phylogenetic development of the Metazoa. They show that animals may possess the intestinal foundations, without arriving at the formation of the intestinal and stomachal cavities. From this it follows in general that we hardly have any reason for assuming the presence of the stomachal cavity in the stock-form of all Metazoa.

This applies also to the two primary germ-lamellæ, which constitute the second important character of the *Gastrula*-stage. Is the middle germ-lamella only developed when the two primary germ-lamellæ, the exoderm and entoderm, are already at least perfectly formed, even if they do not together constitute a *Gastrula*-form? By no means. We can only say that the middle lamella originates somewhat later than the other two germ-lamellæ; but in the majority of cases it originates long before the stomachal cavity is formed, and it may even originate at a time when the process of segmentation is not quite completed. After this differentiation of the first segmentation-cells, the segmentation may still go on in all these layers of cells. We know of such cases with the greatest certainty, from investigations which have been carried on with perfect accuracy. One such instance we know in *Euares*, from the inves-

\* It might be objected that retrogressive metamorphosis is by no means always dependent on parasitism, but that there are animals which pass a free existence and yet undergo a retrogressive metamorphosis, e. g. the males of the Rotatoria. But what is usually regarded as the retrogressive metamorphosis of the male Rotatoria is really only an arrest of development, and consists in the development of these animals remaining stationary at a certain stage, namely at that stage in which they possess no intestinal cavity, but only the foundation for the intestine. In the females a cavity, the intestinal cavity, is formed in this foundation, but not in the males. This mode of development presents essential differences from retrogressive metamorphosis, as in the latter the animals first show a higher organization and afterwards lose it. (See my "Beiträge zur Entwicklung des *Brachionus urceolaris*," in *Zeitschr. für wiss. Zool.* Bd. xxii.)



tigations of Kowalevsky\*. The scorpion also presents similar conditions, according to the researches of Meeznikoff†.

If we wish to sum up the various ontogenetic phenomena, draw conclusions as to the developmental processes from observations, and establish these as the basis for our subsequent observations, we must, in the first place, select the most important phenomena common to all animals in the developmental history of their organization, and distinguish these from the secondary phenomena, which are manifested later and in a different manner. The developmental processes of all animals consist of a gradual differentiation of the cells first formed, which in many cases commences even at the time of segmentation. By the process of segmentation either similar or dissimilar cells are formed. The differences between the segmentation-cells may make their appearance in some animals even at the time of the binary division of the egg-cell, in others not until a much later period. This shows that the commencement of the differentiation occurs at different periods of development in different animals. The subsequent phenomena, however, maintain in different animals a similar and definite direction, consisting in the combination (*zusammenlagern*) of the heterogenous cells into two or three layers. In these layers the cells are similar. At the conclusion of this first differentiation a definite body-form of the embryo may be produced; from the comparison of these forms in different animals we draw conclusions as to whether this form is or is not common to all animals. If it is common, it is of great importance to our general conceptions. If we can derive from this general form the subsequent phenomena of differentiation in the various animals, this form has a great phylogenetic value, because this diversity shows us the course of the different divergences from a common fundamental form. If we would be quite consistent in the consideration of ontogenetic phenomena, we must take these most important phenomena alone into consideration, without mingling them with other organs of later occurrence. The differentiations of the germ-lamellæ are essential for all organisms, because they appear first of all in all animals, and lay a foundation for further organic development.

### III. *General review of the first embryological processes of Animals.*

In order to place ourselves in a right position with regard to the general embryological processes, we must commence from

\* Mémoires de l'Acad. de St. Pétersb. tome xvi.

† Zeitschr. für wiss. Zool. Bd. xxi.

the first processes of segmentation. Unfortunately this is difficult. The embryology of animals, and especially of invertebrate animals, has only for a short time been the subject of zealous investigation. During the last ten years we have become acquainted with so great a store of facts in this department of science, and these materials are so scattered in various natural-history periodicals, that a satisfactory collocation of all that has been published during this period on the history of development is attended with much difficulty. And even when this difficulty is overcome, we have to do with contradictory statements by different observers; so that it is nearly impossible to draw general conclusions from the extant materials.

Let us commence our examination of the process of segmentation and the formation of the germ-lamellæ with those forms in which the process of differentiation occurs earliest. Such cases occur among the Rotatoria, in which, after the first binary division of the egg-cell, the differentiation of the two germ-lamellæ, the animal and vegetative, is already indicated. In each of these first two segmentation-cells, the further segmentation takes place in a very different fashion. The smaller cell continually divides and finally coats the larger cell with its derivatives; and the larger cell also subsequently divides into several cells. We arrive at the terminal form of the differentiation into two germ-lamellæ, which form is perfectly similar to the *Planula*. Instances of the differentiation at a somewhat later stage, after the segmentation has advanced to four uniform segmentation-cells, are much more numerous. They are apparently of very usual occurrence. They are met with in the Mollusca (in the Opisthobranchiata, Prosobranchiata, Lamellibranchiata, &c.), in the Vermes, Turbellaria (Keferstein, Knappert), in some Annelides (*Euaves* and many Annelides observed by Claparède and Meeznikoff), in several Crustacea, in which, however, very different modes of segmentation may be observed in the different genera and even species (Meeznikoff, 'Embryol. Studien an Insecten' and 'Entwicklung der Nebalia' [in Russian], Van Beneden and Bessels, *loc. cit.*). This later differentiation has the same result as that of the Rotatoria; the smaller cells grow round the larger ones, which are richer in fat. As the result of the segmentation of the egg there is produced a two- or three-layered (as in *Euaves*), solid, generally ovoid or spherical body, which may also be characterized as a *Planula*, although in many cases it differs from the true two-layered *Planula* of the Cœlentata by the presence of the three germ-lamellæ.

This process of differentiation of the germ-lamellæ may in

many instances occur at a much later period, after the completion of the segmentation. In most such cases the segmentation-cells are regularly evolved; there are 2, 4, 8, 16, &c. cells, which further divide with the same regularity; in a word, a regular segmentation takes place, producing a solid sphere consisting of uniform cells. For this stage we may retain the name of "*Morula*," by which Häckel indicates the so-called mulberry-stage of segmentation. The *Morula* may become differentiated in different ways. It may at once form the embryo itself, becoming covered with a cuticular membrane and cilia, and escaping as a larva—as is the case, for example, in the digenous Trematoda\* (*Amphistomum subclavatum* &c.), according to the observations of E. van Beneden. The larva of these animals consists of uniform cells and is covered externally with a ciliated membrane. The larva of the Trematoda can probably become further differentiated and even acquire a stomachal cavity.

The Cestoda pass through the *Morula*-stage in the egg. Before the embryo escapes from the egg, the differentiation of its cells commences in it. This differentiation differs in its results from the differentiation of the germ-lamellæ, although the processes are the same in both cases. In consequence of the differentiation there is produced a body consisting of two layers (a central and a peripheral one). But these two layers pass through their further evolution in a somewhat different manner than in the analogous processes of differentiation in other animals. In the Cestoda the peripheral layer becomes converted into a ciliary envelope (or its homologue), and the central layer into a six-hooked embryo. From the researches of E. van Beneden we obtain the data for a comparison of the developmental history of the *Tæniæ* with that of the *Bothriocephali*. This naturalist has shown that after the egg of the Cestoda (both *Tæniæ* and *Bothriocephali*) has passed through a *Morula*-stage (mulberry form), it becomes differentiated into two layers, peripheral and central †. (Similar processes had been previously observed in the *Bothriocephalidæ* by Kölliker, Mecznikoff, and Knoch.) These two layers are then developed in different ways: from the outer one is formed, in the *Bothriocephalidæ*, the embryonal envelope (in the *Tæniæ* it en-

\* Properly speaking a differentiation has already taken place here, inasmuch as the peripheral cells have the cilia, which the central ones do not possess. But this differentiation is essentially distinct from that of the Cestoda and other animals, and it does not lead to the formation of the germ-lamellæ.

† Recherches &c., in Mémoires couronnés de l'Acad. Royale de Belgique, tome xxvi.

tirely disappears); the inner one is developed into a so-called six-hooked embryo, which consists only of homogeneous cells.

We may certainly compare with a *Planula* that state of the embryos of the *Tæniæ* and *Bothriocephalidæ* in which they consist of a two-layered body (therefore before the development of the embryo and the embryonal membrane).

In the other animals which pass through the *Morula*-stage the differentiation of the germ-lamellæ takes place in an exactly similar manner as in the above-mentioned cases (some Copepoda, some Gammaridæ, probably the *Ctenophora* and the *Cœlenterata*, *Hydroid* polypes, and *Sponges*). After the segmentation the uniform cells divide into two layers, which represent two germ-lamellæ, and become further developed into the organs. Unfortunately, in the investigations of the development of many of these animals, the question of the formation of the germ-lamellæ has been very little referred to. It appears to me that in many instances the entoderm has been explained as the nutritive vitellus. But until the formation of the intestinal epithelium in the lower *Crustacea* has been further investigated, we may affirm with perfect justice, from the analogy of the developmental processes in animals which have been better investigated, that the central spherules, abounding in fat, of the crustacean embryos really form the entoderm and not the nutritive vitellus. That in many instances we can see no cells in this part is due to its opacity. In *Astacus fluviatilis* the peripheral parts of the cells of the entoderm, from which the intestinal epithelium is formed, are also very difficult to observe, and only become distinct when they are tinged with carmine or some other colouring-material. At any rate in this instance also we obtain, as the result of differentiation, the same temporary body-form, consisting of two layers, and possessing no cavity in its interior—that is to say, the *Planula*.

In some instances, in which we decidedly have the same process before us, it may be obscured by certain subsidiary phenomena. In most cases this masking is caused by the occurrence of the nutritive vitellus, which is accumulated in the egg in larger or smaller quantities. Such cases occur, for example, in the *Cephalopoda*, in *Reptiles* and *Birds*, and also in *Fishes*. Here the egg-cell which becomes segmented is situated at one pole of the egg. The segmentation may be compared to the regular segmentation, inasmuch as the cells produced by the segmentation are at first uniform and subsequently differ from one another. It is only at a later period that the differentiation of the germ-lamellæ occurs in this aggregation of cells; the germ-lamellæ are mutually arranged

in a manner differing from the true *Planula*-form, but yet remain perfectly homologous with the germ-lamellæ of the *Planula*. These processes also appear to take place in the same way in the scorpion.

Cases may, however, occur in which, after segmentation, a *Planula*-form is not at once produced. Most of these cases have been recently made known by the researches of Kowalevsky and Meeznikoff in the *Ascidia*, *Amphioxus*, *Nemertina*, &c. In these animals the egg passes through a so-called regular segmentation, and at the close of this becomes converted into a vesicle surrounded by uniform cells, which, to distinguish it from the *Planula*, may be named the "*Blastula*." The distinctions between the *Planula* and the *Blastula* are that the former already possesses two germ-lamellæ, while the latter has still to form them. As the *Planula*-form in the *Cœlenterata* issues from the egg and passes into free life, so also can the *Blastula* become free and swim about in the water, as is the case, for example, in the *Nemertina* (Meeznikoff, 'Mémoires de l'Acad. Imp. de St. Pétersb.' tome xiii.). In such a larval or developmental stage we can say nothing of either exoderm or entoderm. The two lamellæ are still quite undifferentiated; this differentiation occurs somewhat later, and leads to a form which differs somewhat from the *Planula*-form. In some cases, before the differentiation into two germ-lamellæ, this *Blastula*-form may form a thickening at one point of its surface, to which the subsequent differentiation is confined, as seems to be the case, for example, in the *Mammalia*. Usually the differentiation commences in the *Blastula* by a portion of its cells beginning to distinguish themselves from the rest by some character.

Let us commence our examination with the processes which indicate the differentiation in the *Blastula* of the *Ascidia*, as these have been best investigated. The first alteration in the *Blastula* consists in its becoming flattened on one side\*. From Kowalevsky's figures we see that at this stage (see Kowalevsky *loc. cit.* fig. 5 and Pl. V. fig. 4) the two germ-lamellæ are already differentiated. The differentiation occurs in the same way in *Lumbricus*, where also the same flattening of the *Blastula* is the first thing that makes its appearance. I must specially cite this first form of the differentiation of the germ-lamellæ, because in most cases in the above-mentioned animals the differentiation of the germ-lamellæ has been confounded with the subsequent invagination; the latter, however, is a

\* Kowalevsky, "Weitere Studien über die Entwicklung der einfachen Ascidiën," in *Archiv für mikr. Anat.* Bd. vii. p. 105.

secondary phenomenon, as we shall see hereafter. The stage in which the first differentiation of the germ-lamellæ occurs is of great importance, because it may serve for comparison with the corresponding stages in other animals which also pass through a *Blastula*-stage in their ontogeny. By the occurrence of the differentiation the *Blastula* will become equivalent to the *Planula*. To distinguish this stage from the true *Blastula*, which consists only of uniform cells, it may be called the "*Diblastula*" (See Pl. V. fig. 4).

The same process of differentiation seems also to be very common among Insects; but it is in these somewhat masked by the presence of a nutritive vitellus. But if we stick to the principal characters of the case now expounded (namely, 1, the occurrence of a one-layered vesicle, and 2, the mode of differentiation of the germ-lamellæ), the first processes of insect-development might also be explained in an analogous fashion. These first processes are well known since the works of Zadach, Weissmann, and Mecznikoff. The differentiation of the germ-lamellæ in Insects has been carefully investigated by Kowalevsky. Kowalevsky, in his investigations, however, has arrived at the conviction that the inferior germ-lamella of Insects constitutes a peculiar formation, and cannot be compared with that of the Vertebrata. He compares the subsequently formed dorsal tube of *Hydrophilus* and the Phryganeidæ with the intestino-glandular lamella of the Vertebrata. I can by no means share this opinion. To me the phenomena of the formation of the germ-lamellæ in the Ascidia appear to be so in accordance with those of *Hydrophilus*, that I certainly can find no obstacle to regarding the inferior germ-lamella of *Hydrophilus* as homologous with that of the Ascidia (and therefore also of *Amphioxus*). We have seen that in the Ascidia the differentiation of the inferior germ-lamella is effected by some cells of the *Blastula* (the cells of the entoderm) beginning to distinguish themselves from the others (the cells of the exoderm). According to Kowalevsky's researches this differentiation in *Hydrophilus* commences in a perfectly similar way. In order to make it easier to see our way with regard to the homology of these two formations, I have given two figures from Kowalevsky's memoirs (Pl. V. figs. 4 and 5).

In the Ascidia a vesicle consisting of uniform cells is first of all produced from the segmentation-cells; in the Insects also the same vesicle occurs, differing from the former only by its being filled with vitellus. In the Ascidia the differentiation of the germ-lamellæ is brought about by some cells of this vesicle beginning to distinguish themselves from the others, and thus forming the foundation of the inferior germ-

lamella; in *Hydrophilus* exactly the same process occurs in the formation of the germ-lamellæ. In the *Ascidia* the intestino-glandular lamella and the middle germ-lamella are formed from the inferior germ-lamella; in *Hydrophilus* the same differentiation takes place in the inferior germ-lamella.

The two forms in which the process of differentiation in the germ-lamellæ commences, (namely 1, the *planula*, in which the two germ-lamellæ are already differentiated, and 2, the *blastula*, in which an indifferent cellular layer, afterwards becoming differentiated, is formed) appear to pass into each other. It is to be hoped that such transitions will hereafter be made known in greater numbers; the development of the *Campanularie* from the ova of *Eucope polystyla*\* may at present serve as an example. The ova of this Medusa pass through a regular process of segmentation, which leads to the evolution of a *Blastula*-stage. This latter form subsequently passes into the *Planula* in this way: in the interior of the blastula the cells of the inferior germ-lamella (entoderm) are formed; and these accumulate more and more, until finally they entirely fill the cavity of the *Blastula*. By this mode of development there is produced from the *Blastula* a form which consists of two germ-lamellæ and possesses no cavity in its interior, *i. e.* a *Planula*-form. *Palæmon* also presents a similar transition into the *Planula*-form in its development; but in it an invagination is formed before the transformation takes place. The stage with the invagination may have a great resemblance to the *Gastrula*-stage; but it is essentially distinguished therefrom by the circumstance that the invaginated part in *Palæmon* does not form the entoderm, as is the case in other true *Gastrula*-forms, but always remains exoderm.

The transitions just indicated may, to a certain extent, explain the mutual relations of the *Planula* and the *Blastula*. The *Planula*-form occurs most frequently in the ontogeny of animals; and for this reason it may be regarded as the fundamental form. The cases in which the *Blastula* passes into the *Planula* appear still further to support this assertion. The other cases in which (as, for example, in *Amphioxus*, the *Ascidia*, &c.) a *Gastrula* originates from the *Blastula*, are united even by the *Blastula*-stage with the case of *Eucope*, and differ from the latter case by the circumstance that they lead very soon to the development of the intestine; here, therefore, the *Planula*-form (which, as is well known, pos-

\* Kowalevsky, 'Beobachtungen über die Entwicklungsgeschichte der Cœlenteraten' (Russian).

sesses no intestine) is overleaped. The production of the *Gastrula* from the *Blastula*-form may be regarded as an abridgment of development.

Hitherto we have considered the processes of differentiation of the germ-lamellæ, and seen that these may be referred to two forms—the *Planula* and *Diblastula*. From this point further processes occur in different manners in different animals, the consideration of which may assist us in obtaining a notion of the import of the *Gastrula*-stage in the ontogeny of animals.

Let us commence our examination with the animals which in their development pass through a *Planula*-stage in the pure form—that is to say, in the early period of their development present a body which consists of two or three germ-lamellæ and has no cavity in its interior. It is in this form that the embryos of the Cœlenterata quit their egg-envelopes; and in this stage they have long been known under the above name.

The development of the *Gastrula* from the *Planula* has been most accurately investigated by Hæckel in the Sponges, and described in detail in his Monograph. The phenomena of this process are as follows:—First of all a cavity is formed in the entoderm of the *Planula*; this stage Hæckel indicates by the name of "*Planogastrula*." The mouth then breaks into this cavity from without, by which the conversion of the *Planogastrula* into the *Gastrula* is effected. In the hydroid polypes this conversion has long been known. By the conversion of the *Planula* into the *Gastrula* the chief processes of the formation of the body of the Cœlenterate are already completed. The body in these animals (Hydroid Polypes, Sponges, &c.) consists during their whole life of these two layers which circumscribe the cavity; only the organs which distinguish the different groups of the Cœlenterata from each other (tentacles, pores, skeletal parts, &c.) are afterwards formed.

It is probable that in the Turbellaria also similar simple processes occur in the formation of the stomachal cavity; but as very little is known about their development, we cannot affirm this. According to Keferstein's statements, the stomachal wall of these animals is produced by the differentiation of the superior layer of cells (exoderm). Unfortunately we do not know the developmental history of the acœlous Turbellaria (*Convoluta*, *Schizoprova*, &c.). In their organization these are distinguished from the *Planula* only by the presence of the mouth. From this it may be supposed that the conversion of these animals from the *Planula* consists only in the perforation of the buccal orifice.



In all other animals which pass through the *Planula*-form in their development, the developmental phenomena occur nearly in the following order:—After the *Planula*-stage the foundations of various external and internal organs, which appear in these animals as typical, persistent, or larval organs, are formed, *e. g.* the limbs, the shell, the velum, &c.; then the anterior intestine and the anus are invaginated; and finally the intestinal cavity is developed in the interior of the vegetative lamella. This sequence I have endeavoured to represent by the already cited three stages in the development of the oyster (Pl. V. figs. 1–3). With regard to the invagination of the anterior intestine, I have already noted that it is a secondary phenomenon which cannot be compared to the so-called invagination of the exterior lamella of the *Ascidia*, *Amphioxus*, &c.—that is to say, to the *Gastrula*-stage of these animals. The middle intestine, which corresponds to the stomachal cavity of the *Gastrula* (of the *Cœlenterata*), is only developed in our cases when the typical organs are already formed and the middle lamella is differentiated. We may conclude as to the existence of the latter from statements derived from very thorough investigations (*Euaxes*, *Tubifex*, &c.). In these cases, therefore, no *Gastrula*-stage is formed.

If we take the *Vermes* first into consideration, we have an example in *Euaxes*, which has already been repeatedly mentioned. As the formation of the intestinal cavity in this animal has already been spoken of, I will only mention here that the invaginations for the mouth and anus (anterior and posterior intestine) are produced rather early. The *Chætopoda* have also been referred to above. We have seen that in them also the ciliary bands and tufts are first formed, then probably the mouth is invaginated, and finally a stomachal cavity is produced in the interior. (See Claparède and Mecznikow *loc. cit.*)

With regard to the *Mollusca*, the statements of Lovén, Lacaze-Duthiers, Gegenbaur, and myself have already been mentioned. Although we have seen that the statements of different observers with respect to this type of animals differ somewhat from each other, and that the intestine originates from the exoderm according to some, and from the entoderm according to others, it is nevertheless probable that in most animals of this type the sequence of the developmental phenomena is accordant. If the development takes place in the same way as in the oyster, the shell, velum, and buccal invagination first appear, and it is only afterwards that the intestinal cavity makes its appearance. The development of the *Pteropoda*, *Heteropoda*, and *Prosobranchiata* (*Calyptrea*,

*Trochus*, *Vermetus*, *Entoconcha*, &c.) takes place in the same manner.

The further developmental phenomena of the animals which pass through the *Blastula*-stage in the course of their ontogeny, may occur in different ways. If we commence with the embryonal state of the *Ascidia*, which constitutes a flattened vesicle (Pl. V. fig. 4), and in which the differentiation into two germ-lamellæ has already been effected, we see that the subsequent phenomena consist in the whole embryo acquiring a cup-like form (fig. 5). This cup, consisting of two layers, afterwards passes into the *Gastrula*-stage (as is well known in the *Ascidia*, *Amphioxus*, *Lumbricus*, &c.). In consequence of these changes (of the invagination) the stomachal cavity of the *Gastrula* is produced; but the stomach-wall has been differentiated earlier, during the flattening.

Whilst in the last-mentioned cases the embryo (*Diblastula*) is converted into the *Gastrula*-form, the corresponding *Diblastula*-form of the insect undergoes quite different changes. In these the entoderm sinks into the nutritive vitellus, and is gradually covered from without by the exoderm. The divergence of the two corresponding stages of development in the *Ascidia* and in *Hydrophilus*, both of which may be derived from a common *Diblastula*-form, is elucidated by the two figures 6 and 7, in Plate V.\*

These differences in development lead finally to the totally divergent conditions of the subsequent embryonal phenomena in these two animals. Whilst in the *Gastrula* (*Ascidia*) the intestinal cavity is already sketched out, it will only be formed afterwards in the insect, and, indeed, in quite another manner than in the *Gastrula*.

From this it is clear that the formation of the stomachal cavity in these two cases is a secondary phenomenon, governed by different later conditions of the exodermal and entodermal layers. The most important phenomenon in both cases is the differentiation of the germ-lamellæ from an indifferent cell-layer, therefore that stage of development represented in figs. 4 and 5. They are of great importance, chiefly because they represent the first processes which are common to the two forms (*Ascidia* and *Insecta*), and from which the divergence of the subsequent developmental forms starts.

\* The developmental states which occur in *Hydrophilus* at the period of the closing of the groove (see Kowalevsky, *loc. cit.* Taf. ix. figs. 21-25) may serve as an inducement for assuming the occurrence of the *Gastrula*-stage in this animal. But to me this assumption seems to be scarcely justified, because the same process takes place without any such formal condition in *Gastropacha pim.* (See Kowalevsky, Taf. xii. figs. 1-6.)

If we regard the differentiation of the germ-lamellæ as the chief phenomenon, and the formation of the intestinal cavity as a secondary one, it is clear that the *Gastrula*-form with the stomachal cavity, in these cases also, as in development from the *Blastula*, cannot be regarded as the fundamental form.

From this brief revision of the first embryonal phenomena in animals it follows that the *Gastrula*-stage may originate from the *Planula* or *Blastula* in consequence of secondary, subsequently occurring alterations of the latter; in most instances it is not produced. After these observations I need hardly ask whether a form proper to only a few animals can represent the stock-form of all Metazoa, it being understood that in other animals we see the development take place quite independently of this form? The reason of the incorrectness of the *Gastræa* theory consists in the fact that in the stock-form of the *Gastræa* a secondary embryonal phenomenon (the formation of the stomachal cavity) is placed in juxtaposition with the primary and most important of these phenomena (the formation of the germ-lamellæ). The incorrectness lies in the assumption that the *Gastrula* is that early state of development "in which the embryonal animal body represents the simplest conceivable form of the person" ('*Gastræatheorie*,' p. 17). Why are we to accept as the simplest being an animal which is already provided with a stomachal cavity, when we are acquainted with Metazoa (the acœlous Turbellaria) which possess no stomachal cavity? Such acœlous Metazoa are represented by the *Gastrula* before it acquires the stomachal cavity and while it swims about as a *Planula*-form (in the Cœlenterata). Hæckel has placed this *Planula* among the animals which have no germ-lamellæ, among the Protozoa. (See the synoptical table in the '*Gastræatheorie*'). Such a combination is quite unintelligible to me; for Hæckel himself says, in his Monograph of the Calcispongiæ, that the differentiation of the germ-lamellæ occurs even in this stage. It proves the artificiality of the idea of the "*Gastrula*," that it should stand as a "dividing boundary" between the Protozoa and Metazoa. When the *Planula* of the Cœlenterata acquires a stomachal cavity and a mouth, it becomes converted into a Cœlenterate (Metazoon); why should it as a *Planula* represent a Protozoon, if it possesses the two germ-lamellæ which the Protozoa have not, and which are only produced by the process of segmentation, which the eggs or germs of the Infusoria do not pass through?

In the short revision of the first embryonal processes in animals we have seen that in most instances the two germ-

lamellæ constitute a form which resembles the *Planula*-form of the Cœlenterata and differs from this form only in certain animals by the further differentiation of the middle germ-lamella. The other form, from which the differentiation first commences, and which consequently is not to be compared to the *Planula*, I have called "*Blastula*," merely in order to indicate by this name that developmental state of some animals starting from which differentiation of the germ-lamellæ occurs somewhat otherwise than in the *Planula*. We have met with this form in various animals, and briefly explained their further process of differentiation. The simplest differentiation consists in that some cells of the *Blastula* begin to distinguish themselves from the rest. By this, two germ-lamellæ are at once indicated, and the grade of organization equivalent to that of the *Planula* is attained. The two germ-lamellæ may be further developed in different ways: either they may constitute a body, which is the *Gastrula* (as in *Amphioxus*, the *Ascidia*, &c.); or the inner germ-lamella may be covered by the outer one, by which no *Gastrula*-form is produced (as in the *Insecta*).

In these brief remarks on the *Gastræa* theory I have only desired to bring together the facts with which I endeavoured to clear up the significance of that theory for myself. The negative result at which I arrived rests upon facts, especially on these—that the *Gastrula* is not of general occurrence, and that the embryological phenomena cannot be brought into causal connexion with this fundamental form. Even if the *Gastrula* were of as general occurrence as Hæckel states, this would by no means prove that it is truly an ontogenetic fundamental form; for what do we gain by the assumption that the *Gastrula* is a fundamental form of the development of all Metazoa, if we cannot by this form explain the differences in the development of nearly allied animals (e. g. *Amphioxus* and other Vertebrata, Ctenobranchiata and the other Proso-branchiata, &c.)? By the *Gastræa* theory we cannot explain the difference in the development of *Lumbricus* and *Euaxes*. But very many such examples exist; and they show that, between animals standing near each other systematically, essential differences may occur in the foundation of their organs. This fact, however, appears so paradoxical only because we are now accustomed to deduce the relationship of animals only from anatomical facts, and to conclude from similarity of organization that there is similarity of developmental processes. But in order to ascertain the mutual relations of organized forms, we should employ all the methods of natural history; we must regard the structure of the mature organic forms as the result of the ontogenetic pro-

cesses, and not judge of the ontogenetic facts merely from the opinion derived from the anatomical facts. If we desire to take an objective view, we cannot say that when two different modes of development "occur in very nearly allied forms" they are of no consequence to us on account of their relationship\*. If the phylogenetic fundamental law is correct, the relationship of animals must only be ascertained from ontogeny; otherwise the idea of relationship, which is derived only from tectological facts, is a preconceived opinion.

In now concluding my remarks, I hope in these few words to have furnished the factual evidence:—

1. That the most important factor in the ontogeny of animals is the first differentiation of the germ-lamellæ.

2. That this differentiation commences in different animals at different periods of their development, and in most cases leads to the *Planula*-form, which occurs in all animals, either in the pure form (in most animals) or in a modified form (Vertebrata and some invertebrate animals), and even exists as free-living animal forms. In many instances the *Planula*-form may be overleaped and replaced by the *Diblastula*.

3. That the development of the stomachal cavity is a later, secondary developmental phenomenon, which occurs in different animals in different stages of development, and cannot take a place in the idea of the fundamental form of development.

4. That therefore the *Gastrula*-form cannot be accepted as a fundamental form in the developmental history of all Metazoa; and, consequently,

5. That the problematical form "*Gastræa*" cannot be accepted as the "stock-form" for the higher animal stocks.

#### EXPLANATION OF PLATE V.

*Figs. 1, 2, 3.* Three developmental stages of the oyster (original); *Ex.* exoderm; *En.* entoderm; *V.* velum; *S.* shell; *M.* invagination of the anterior intestine; *D.* intestine.

*Fig. 4.* *Diblastula* of an Ascidian (from Kowalevsky: "Weiterer Studien," &c., in Arch. für mikr. Anat. Bd. vii. Taf. x. fig. 5): *Ex.* exoderm; *En.* entoderm.

*Fig. 5.* *Diblastula* of *Hydrophilus* (from Kowalevsky: "Embryol. Studien," &c., in Mém. de l'Acad. de St. Pétersb. tome xvi. Taf. ix. fig. 20): *Ex.* exoderm; *En.* entoderm; *Nd.* nutritive vitellus.

*Fig. 6.* *Gastrula* of an Ascidian (from Kowalevsky, l. c. Taf. x. fig. 6): *Ex.* exoderm; *En.* Entoderm.

*Fig. 7.* Transverse section through the embryo of *Hydrophilus* (from Kowalevsky, l. c. Taf. ix. fig. 26): *Ex.* exoderm; *En.* entoderm.

\* Häckel, Die Kalkschwämme, Bd. i. p. 467.

II.—*Notices of British Fungi*. By the Rev. M. J. BERKELEY, M.A., F.L.S., and C. E. BROOME, Esq., F.L.S.

[Continued from vol. xi. p. 349.]

[Plates I. & II.]

1402. *Agaricus* (*Lepiota*) *cinnabarinus*, Fr. Ep. ed. 2, p. 36.

This very fine species was sent from New Pitsligo, Aberdeenshire, by the Rev. J. Fergusson.

1403. *A.* (*Armillaria*) *subcavus*, Schum.; Fr. Ep. ed. 2, p. 46.

Cirencester, Nov. 1873, Miss Broadwood. An entirely white variety.

\**A.* (*Tricholoma*) *lascivus*, Fr. Ic. tab. 38. fig. 1.

Forres, Rev. J. Keith. A specimen, certainly belonging to this species, was brought to Hereford by Mr. Renny, with decidedly decurrent gills.

1404. *A.* (*Tricholoma*) *panæolus*, Fr. Ic. tab. 36. fig. 2.

Street, Somersetshire, J. A. Clark, Esq. Stem longer than usual.

1405. *A.* (*Tricholoma*) *pædidus*, Fr. Ic. tab. 46. fig. 1.

Abergavenny, J. Renny; Wollaston, Norths., Miss Hume.

1406. *A.* (*Clitocybe*) *diatretus*, Fr. Ep. ed. 2, p. 104.

Coed Coch. Gathered at the same time with *A. fragrans*, from which it was at once distinguished by the total absence of the peculiar odour of that species.

1407. *A.* (*Clitocybe*) *angustissimus*, Fr. Ic. tab. 59. fig. 2.

In woods. Ascot, 1873.

1408. *A.* (*Collybia*) *muscigenus*, Schum.

Coed Coch, 1873.

1409. *A.* (*Collybia*) *ambustus*, Fr. Ic. tab. 70. fig. 2.

On burnt earth. Kew; Coed Coch.

1410. *A.* (*Mycena*) *galericulatus* v. *calopus*, Fr. Ic. tab. 80. fig. 2.

On blocks of wood in a fernery. Coed Coch, 1872. Extremely beautiful.

1411. *A.* (*Mycena*) *ætites*, Fr. Ic. tab. 81. fig. 5.

Ascot, 1873.

1412. *A.* (*Omphalia*) *philonotis*, Lasch.; Fr. Ic. tab. 76. fig. 1.

On *Sphagnum*. Glamis, Rev. J. Stevenson.

1413. *A.* (*Omphalia*) *umbelliferus*, L., var. *abiignus*.

In considerable numbers on a very decayed fir-stump. Pale yellow. Coed Coch, 1873.

\**A.* (*Pleurotus*) *septicus*, Fr.

In great numbers on a turf of *Salix polaris* from Spitzbergen in a greenhouse in the Botanic Garden at Cambridge.

\**A.* (*Pluteus*) *parvulus*, Weinm.

A very minute form occurs on the soil of garden-pots in stoves, with a transparent, minutely tomentose stem; volva white, silky.

\**A.* (*Entoloma*) *placenta*, Batsch.

Glamis, Rev. J. Stevenson, April 20, 1874. Exactly the plant of Batsch.

1414. *A.* (*Entoloma*) *resutus*, Fr.

Pastures. Glamis, Rev. J. Stevenson, no. 380.

1415. *A.* (*Nolanea*) *icterinus*, Fr.

Edensor, J. Renny, Esq. Exactly according with a figure from Fries.

1416. *A.* (*Nolanea*) *cælestinus*, Fr.

M. Terry, Esq., Oct. 1872.

1417. *A.* (*Hebeloma*) *Bongardii*, Weinm. Fl. Russ. p. 190.

Growing in large quantities on the Culbin sand hills, near the Findhorn mouth, G. Norman.

\**A.* (*Flammula*) *scambus*, Fr.

On an old stump. Moccas, Herefordshire, 1873.

\**A.* (*Flammula*) *inopus*, Fr.

On decayed stumps of fir or larch, Hereford, J. Renny. Ascot, 1873. The specimens agree exactly with Bolton's figure, which was previously the only authority for the species being British.

1418. *A.* (*Hypholoma*) *storea*, Fr.

This curious species occurred last year at the base of different trees at Ascot and at Coed Coch; and it has also been found by Mr. W. G. Smith, and was exhibited at South Kensington, October 1873. It is considered very rare by Fries; but it is probably one of those species which are abundant in some one year, and are not found again for a generation.

1419. *A.* (*Hypholoma*) *elæodes*, Fr.

Slough, M. Terry, Esq., 1873.

1420. *Hygrophorus* *fornicatus*, Fr.

Holme Lacy, Moccas Park, Herefordsh.; Batheaston, 1873.

1421. *Cantharellus albidus*, Fr. Fl. Dan. tab. 1293.

Coed Coch, Sept. 1872, and in the same spot, Oct. 1873. Exactly agreeing with the figure in 'Flora Danica.'

1422. *C. Stevensoni*, B. & Br. Pileo orbiculari umbilicato, pallido glabro; margine inflexo; stipite cylindrico, subtiliter pulverulento albo dein obscuriore; lamellis decurrentibus pallidis antice fuscatis.

On very rotten wood amongst moss. Glamis, Rev. J. Stevenson, March and April 1874.

Pileus about 2 lines across; stem  $\frac{1}{4}$  inch high,  $\frac{1}{2}$  line thick, with a little white mycelium at the base. Very near to *C. cupulatus*; but that is very strongly umbonate when young, and the umbo is always visible at the bottom of the umbilicus; the habitat, moreover, is different.

1423. *Lentinus scoticus*, B. & Br.; Fr. Ep. ed. 2, p. 485. Inodorus; pileo glabro hygrophano multiformi, reniformi expanso; stipite omnino obsoleto, brevi vel longo deorsum fusco-vestito, plerumque umbilicato; margine lobato sinuato; lamellis dentatis decurrentibus; mycelio repente fusco.

On decayed *Ulex* and rotten wood. Glamis, Rev. J. Stevenson; Menmuir, Rev. M. Anderson.

Inodorous or, at any rate, without any odour of aniseed; extremely variable; pileus  $\frac{1}{2}$ – $1\frac{1}{2}$  inch broad, smooth, hygrophanous, pallid, at length brownish, either quite stemless and reniform, or variously stipitate, solitary or caespitose, sometimes deeply umbilicate, lobed at the margin, and sinuate or plicate; stem, when present, varying from 2 lines to as many inches; gills rather distant, strongly toothed, decurrent when the stem is developed. Very rarely two pilei are joined. The nearest ally to this curious species is *Lentinus omphalodes*.

1424. *Boletus sulfureus*, Fr.

This fine species was found in great abundance on sawdust at Forres by the Rev. J. Keith.

1425. *B. æreus*, Bull.

Surrey, M. Terry, Esq.

Spores oblong, oblique at the base, .0004–.0005 inch long, .0002 wide.

1426. *B. carnosus*, Rostk.

Stoke Pogis, M. Terry, Esq.

\**Polyporus lentus*, B.

On *Ulex*. Glamis, Rev. J. Stevenson, no. 58.

1427. *P. floccopus*, Rostk. St. Deutschl. Fl. no. 28, tab. 13.

On dead wood. Glamis, Rev. J. Stevenson.

1428. *P. trabeus*, Fr.

Glamis, Rev. J. Stevenson; Menmuir, Rev. M. Anderson.

1429. *P. borealis*, Fr.

Slough, M. Terry, Esq.

1430. *P. (Anodermei) Keithii*, B. & Br. Conchatus; pileo rubro-fusco, processibus dentiformibus hispido; hymenio pallido; dissepimentis laceratis.

On dead wood. Forres, Rev. J. Keith.

About  $\frac{1}{2}$  inch across; conchiform, stemless, decurrent behind,



bright red-brown, rough, with rigid processes; hymenium pallid; dissepiments lacerated.

1431. *P. callosus*, Fr.

On dead wood. Glamis, Rev. J. Stevenson.

1432. *P.* (Resupinati) *collabefactus*, B. & Br. Strato glaberrimo corticioideo; poris primum e subiculo collabendo excavatis brevibus; margine obtuso.

On dead wood. Glamis, Rev. J. Stevenson.

The barren parts resemble exactly a very smooth *Corticium* after the fashion of *C. calceum*; the pores seem first to arise from the mere collapsing of the substance, always shallow; margin obtuse.

1433. *P.* (Resupinati) *Rennyi*, B. & Br. Subiculo crasso, pulvinato, pulverulento; poris parvis, elongatis; dissepimentis tenuibus.

On wood, and running on to the ground. Hereford, J. Renny, Nov. 1873; Glamis, Rev. J. Stevenson.

Forming a thick, at first somewhat frothy, then pulverulent mass, white, turning to lemon-coloured when dry; pores sparingly produced, white, elongated. A very singular species.

1434. *P.* (Resupinati) *blepharistoma*, B. & Br. Totus resupinatus, niveus; mycelio arachnoideo subfarinoso; poris parvis; dissepimentis tenuibus; margine ciliato-dentatis.

On dead wood. Glamis, 1874.

Very thin and delicate; the ciliato-dentate margin of the pores is very elegant.

1435. *Hydnum squamosum*, Fr. Ep. ed. 2, p. 598.

Exhibited by W. G. Smith at the Fungus show, South Kensington, Oct. 1873. A very interesting addition to the British flora.

1436. *H. melleum*, B. & Br. Melleum, effusum, tenue; margine subtiliter byssoideo; subiculo dentibusque, apice acutis quandoque divisus, deorsum pulverulentis, medio nudis.

On broken rails lying on the ground. Coed Coch, 1873.

1437. *H. Stevensoni*, B. & Br. Album, effusum, subtus farinaceum, hic illic byssaceum; aculeis cylindricis, obtusis vel truncatis quandoque compressis, apice pulverulentis.

Glamis, Rev. J. Stevenson, March 1874.

1438. *H. anomalum*, B. & Br. Pallide flavum; strato tenui gelatinoso; dentibus primum granuliformibus, dein stipitatis sursum obtuse divisus.

In the inside of a very rotten ash tree. Near Langridge, Somersetshire, C. E. B., March 9, 1872.

Substance of teeth tough, with large ovate or globose vesicles immersed in it; spores globose, shortly pedicellate.

Resembles externally Corda, Anleit. fig. 71; but the substance is very different. Near to Fries's genus *Mucronella*.

PLATE I. fig. 1. *a.* plant, slightly magnified; *b.* horizontal section; *c.* spores, both more highly magnified.

1439. *Radulum tomentosum*, Fr. Ep. ed. 2, p. 624.

On *Pyrus aucuparia*. Menmuir, Rev. M. Anderson.

1440. *R. deglubens*, B. & Br. Orbiculare, ferrugineum, subdiaphanum; tuberculis erectis, subcylindricis, irregularibus, sparsis; interstitiis laevibus, e sporis albis pulverulentis.

On ash, Jan. 30, 1874. Forbes, Rev. J. Keith; New Pitligo, Rev. J. Fergusson. About  $\frac{1}{2}$  inch across.

1441. *R. corallinum*, B. & Br. Effusum, album; subiculo nitido tenuissimo pelliculoso; tuberculis fasciculatis deorsum divisis, obtusis, coralloideis.

Scotland. Effused for 3 inches over oak-branches partially covered with lichens; fascicles of tubercles  $\frac{1}{4}$  inch or more across.

1442. *R. epileucum*, B. & Br. Effusum, ochroleucum, totum resupinatum; subiculo niveo, strato ceraceo tecto; tuberculis sparsis cylindricis, apice sub lente fimbriatis deciduis.

On decorticated wood. Glamis, Rev. J. Stevenson. Effused for several inches; tubercles falling out and showing the white mealy subiculum, round which is an annular depression.

1443. *Grandinia crustosa*, P.; Fr. Ep. ed. 1, p. 528.

On *Polyporus versicolor*. Glamis, Rev. J. Stevenson, Feb. 1874.

1444. *Kneiffia subgelatinosa*, B. & Br. Tenuis e subflavo cremicolor; granulis minutis subgelatinosis, apice fimbriatis.

On stumps of felled firs. Glamis, Rev. J. Stevenson, April 1874. Accompanied by a green alga, which penetrates the tissue of the fungus.

1445. *Craterellus clavatus*, Fr. Ep. ed. 1, p. 533.

In a beech wood. Bisham, Berks, Rev. G. H. Sawyer.

1446. *Cyphella fraxinicola*, B. & Br. Minuta, orbicularis extus nivea breviter villosa; disco flavo e sporis fuscescente, prolifero.

On ash. Batheaston, Dec. 20, 1873.

1447. *Hyphelia rosea*, Fr.

New Pitligo, Rev. J. Fergusson.

Spores minute, globose.

1448. *Clavaria curta*, Fr.

On the ground. Coed Coch, Holme Lacy.

\**Clavaria tuberosa*, Sow.

On sticks. Forbes, Rev. J. Keith.

Exactly the long-lost plant of Sowerby, which is perhaps

too near *C. ardenia*; and possibly the same may be said of *C. juncea*, notwithstanding the great difference of size.

\**Hydnangium carneum*, Wallr.

This has occurred lately to Dr. Dickson at Edinburgh about the roots of *Eucalyptus*.

Spores  $\cdot 013$ – $\cdot 014$  inch in diameter.

1449. *Leptostroma glechomatis*, B. & Br. Maculis fulvis; peritheciis irregularibus, minutis, epiphyllis.

On leaves of ground-ivy. Scotland.

Spores minute, oblong.

1450. *Leptothyrium pictum*, B. & Br. Maculis rufis hic illic pallidioribus, fertilibus fusco marginatis; peritheciis nitidis ocellatis; sporis subcymbæformibus curvulis.

On leaves of *Lonicera*. Glamis, Rev. J. Stevenson. A very pretty and distinct species.

\**L. Juglandis* occurred abundantly last year on the green coat of walnuts; on examination the spores were just those in Madame Libert's specimens on walnut-leaves. Spores  $\cdot 0008$  inch long, but not (as she says) ellipsoid.

1451. *Stilbum cuneiferum*, B. & Br. Stipite sursum parce ramoso, vel simplici; capitulis ovatis; sporis cuneiformibus.

On rotten cabbage-stalks. Batheaston, April 1873. Mentioned in Rabenh. no. 1662, as mixed with *Periconia brassicæcola*.

Stems attenuated upwards, simple, or slightly divided, consisting of compacted threads, which are free above and bear the obversely wedge-shaped, pale greenish-brown spores, which are  $\cdot 0004$ – $\cdot 00045$  inch long. Habit that of *S. rigidum*.

PLATE I. fig. 2. *a.* plant *in situ*, slightly magnified; *b.* tip, more highly magnified; *c.* *d.* spores.

1452. *Periconia brassicæcola*, B. & Br. Sporis irregularibus, ovatis, pallide brunneis, utroque apice plus minus attenuato.

Forming dense masses in the inside of rotten cabbage-stalks. Batheaston, April 1873.

Stem black; heads globose, at first grey, then black; spores  $\cdot 0002$ – $\cdot 0004$  inch long, cinereous.

PLATE I. fig. 3. *a.* plant *in situ*; *b.* portion of the head; *c.* portion of the stem; *d.* spores. All more or less highly magnified.

1453. *P. Phillipsii*, B. & Leight. Minutissima; stipite sursum attenuato; capitulo globoso; sporis globosis, granulatis.

Trefriw, Rev. W. A. Leighton, 1874. On soil with a minute species of *Thelocarpon*.

Stem about equal in height to the diameter of the head, thick for the size of the plant; spores  $\cdot 0004$  inch in diameter.

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Looks at first sight like a little *Sphinctrina*. So minute that it is quite invisible to the naked eye.

1454. *Peronospora calothea*, De By.

On *Galium aparine*. Forden, April, Rev. E. Vyse.

1455. *P. interstitialis*, B. & Br. Maculis luteis, a venis limitatis; floccis brevissimis, flexuosis; sporis ovatis terminatis.

On leaves of primrose. Glamis, Rev. J. Stevenson; Menmuir, Rev. M. Anderson.

Spots hypophyllous, yellow, confined to the interstices of the veins, or very rarely extending slightly beyond them; spores often seated obliquely,  $\cdot 0006$ – $\cdot 0007$  inch long. Allied to *P. obliqua*, Cooke.

1456. *P. rufibasis*, B. & Br. Maculis epiphyllis nitidis fulvis; hypophyllis pallidis; sporophoris linearibus; sporis obovatis elongatisque variis, oblique sitis, brevissime pedicellatis.

On leaves of *Myrica gale*. Glamis, Rev. J. Stevenson.

The spots on the upper surface of the leaves are very conspicuous. Closely allied to *P. obliqua* and the last. Spores very variable in length.

1457. *Penicillium megalosporum*, B. & Br. Niveum, breve; floccis fasciculatis; sporis globosis elongatisque lævibus.

In an old chicken-coop. Menmuir, Rev. M. Anderson.

Spores  $\cdot 0005$ – $\cdot 001$  inch in diameter, or equally variable when oblong.

\**Fusarium minutulum*, Cd.

On rotten boards. St. Catherine's, Bath, Jan. 5, 1874.

Spores  $\cdot 0002$  inch long.

1458. *Cylindrosporium rhabdospora*, B. & Br. Maculis amphigenis, orbicularibus, brunneis; sporis albis radiantibus, oblongis, triseptatis, obtusis, utrinque paululum excavatis.

On leaves of *Plantago*. Glamis, Rev. J. Stevenson.

Spores forming little radiating fascicles, oblong, slightly hollowed out at the sides,  $\cdot 0008$ – $\cdot 002$  inch or more long. Sometimes a second is developed at the tip of the first.

\**C. ficariæ*, B.

Common on leaves of *Ranunculus ficaria*.

This is placed by Cooke in *Glæosporium*; but the spores are not contained in a perithecium. *Cylindrosporium concentricum*, Grev., is, on the contrary, a true *Glæosporium*, and is not uncommon on cabbage-leaves.

1459. *C. niveum*, B. & Br. Maculis fusco marginatis; sporis niveis, oblongis, uniseptatis, breviter pedicellatis.

On *Caltha palustris*. New Pitsligo, Rev. J. Fergusson.

Spots numerous, crowded, one or two lines across, often confluent; spores oblong, uniseptate, when fully grown about  $\cdot 002$  inch long.

1460. *Septoria hyperici*, Desm. Ann. d. Sc. Nat. 1842, v. 17. p. 110.

Glamis, Rev. J. Stevenson.

Spores  $\cdot 002$  inch long.

1461. *S. stachydis*, Desm. l. c. 1847, v. 8. p. 19.

On leaves of *Stachys sylvatica*. Glamis, Rev. J. Stevenson.

Spores slender, thread-like,  $\cdot 001$ – $\cdot 0015$  inch long.

1462. *Melanconium elevatum*, Cd.

On oak. Langridge, Dec. 1872, C. E. B.

Spores  $\cdot 0005$  inch long.

1463. *Pestalozzia funerea*, Desm.

On dead *Cupressus macrocarpa*. Hatton, near Hounslow.

1464. *Puccinia Andersoni*, B. & Br. Maculis orbicularibus, brunneo cinctis; soris hypophyllis minutis congestis; sporis oblongis, centro constrictis, obtuse apiculatis.

On the underside of leaves of *Cnicus heterophyllus*. Falls of Noran, Glen Ogle, June 1874, Rev. M. Anderson.

Spots visible only on the upperside, orbicular, surrounded by a brown border, and a central patch indicating the position of the minute crowded sori, which are almost concealed by the pubescence of the leaf; spores very like those of *P. discoideum* as figured by Corda. This was originally found at the Den of Airlie by Mr. Gardiner.

1465. *P. Fergussoni*, B. & Br. Maculis pallidis; soris minutis in orbiculos congestis; sporis oblongis, obtuse apiculatis.

On leaves of *Viola palustris*. New Pitsligo, Rev. J. Fergusson.

This is very different from *P. violarum*, not only in the minute crowded sori, but in the elongated spores.

1466. *P. senecionis*, Libert, i. no. 92; Cd. fasc. iv. fig. 54.

On *Senecio aquatica*. Noran woods, Menmuir, Rev. M. Anderson.

1467. *P. tripolii*, B. & Br. Soris magnis; sporis elongatis, apice truncatis binodulosis, vel appendice crassa mammæformi præditis.

On leaves of *Aster tripolium*. New Pitsligo, Rev. J. Fergusson.

We have no authentic specimen of *P. asteris*, Schwein; but samples from different parts of the United States differ materially from the plant before us, of which, however, at present we have seen only a single specimen.

1468. *Coleosporium pingue*, Lévl. Var. *alchemillæ*.

This appears not to be uncommon. The sori are crowded, and radiate from the base of the leaf. We have it from Scotland and Wales; and it occurs in Northamptonshire.

1469. *Æcidium incarcerationum*, B. & Br. Soris minutis, in orbes irregulares congestis; peridiis omnino in parenchymate foliorum inclusis; sparsis pallidis. Rab. Exs. no. 1492.

On leaves of *Sagittaria*. Bungay, Mr. Stocks.

The tissue of the peridium is far more delicate than in most of the species.

\**Æ. berberidis*, P.

On leaves of *Mahonia*. Glamis, Rev. J. Stevenson.

Turning black when old. Some of the spores are embraced by the curved tips of the creeping mycelium, exactly after the manner of the supposed sexual phenomena in several Fungi.

\**Æ. scrophulariæ*, De C.

On *Scrophularia nodosa*. Woods of Fearn, Rev. M. Anderson.

Very highly developed, looking like a little orange *Peziza* with an inflexed border. These specimens do not turn brown.

The above was written when we first received the plant from Mr. Anderson; but in subsequent specimens the sori of the *Æcidium* were surrounded with flat irregular dark specks, which on examination proved the following species of *Uromyces*, which has lately appeared in the 'Gardener's Chronicle' with a figure.

1470. *Uromyces concomitans*, B. & Br. Soris in annulum congestis irregularibus planis; sporis obovatis, lævibus; pedicellis deorsum attenuatis.

Surrounding *Æcidium scrophulariæ*. Woods of Noran and Fearn, Rev. M. Anderson.

1471. *Protomyces microsporus*, Ung. Maculis candidis sporis globosis, pallidis.

On leaves of *Ranunculus ficaria*. New Pitsligo, Rev. J. Fergusson.

On examining the specimens of *Cylindrosporium ficariæ* in Berkeley's 'British Fungi,' we find the same globose bodies, and therefore suppose that there must be some intimate connexion between the two. Dr. Farlow, on his late visit to this country, brought specimens from De Bary which seemed to be identical.

1472. *P. chrysoplenii*, B. & Br. Maculis albis crassiusculis; sporis globosis, hyalinis, pedicellatis.

On leaves of *Chrysoplenium oppositifolium*. New Pitsligo, Rev. J. Fergusson.

1473. *P. Fergussoni*, B. & Br. Maculis punctisve brunneis, irregularibus; sporis obovatis, primum hyalinis, brevissime pedicellatis, lævibus, dein fuscis.

On leaves of *Myosotis*. New Pitsligo, Rev. J. Fergusson.

These curious productions of very uncertain affinity are too

interesting to pass over, though further information is very desirable.

1474. *P. menyanthes*, De By. Brandpilz. p. 19; Rab. Exs. no. 1500.

On leaves of *Menyanthes*. Bungay, Mr. Stocks. On *Comarum palustre*, Scotland.

1474 bis. *P. macrosporus*, Ung.

On leaves and stalks of *Æcopodium*. Rev. M. Anderson.

1475. *Myrotrichum ochraceum*, B. & Br. Flavum, dein virens; floccis sursum elongatis acutis, ramulis deflexis.

On the shavings of hurdle-makers. Hermitage Woods, St. Catherine's, Bath, March 1874.

Spores .00015 inch in diameter. When placed in alcohol they adhere in clusters as if surrounded by a membrane or involved in mucus.

In *M. æruginosum* the flocci are hamate (a character apparently overlooked by Montagne, whose specimens we have re-examined), in *M. deflexum* branched to the extremity. In this they project without any branchlets far beyond the common mass.

PLATE I. fig. 4. *a.* plant, slightly magnified; *b.* base of spines, forming a network; *c.* mass of spores; *d.* tip of spine; *e.* spores. All more or less highly magnified.

1476. *Gyromitra gigas*, Fr.

On the ground. Coed Coch, Mrs. Lloyd Wynne, March 1874. It has also occurred to Mr. Currey.

1477. *Vibrissea margarita*, White, Scott. Nat. ii. 1874, p. 218.

On wet wood. Perth, Dr. Buchanan White; Braemar Mor, Schron.

Distinguished by its very hairy stem.

1478. *Peziza* (Helvelloideæ) *cochleata*,  $\beta$ . *alutacea*, Fr.; Schæff. t. 150; Berg. t. 173.

Bowood, C. E. B.

1479. *P.* (*Geopyxis*) *ciborium*, Fr.

On the ground. C. Spencer Perceval.

The larger form, which seems quite different from the *Peziza* figured in 'Flora Danica.' There are a few brown mycelioid fibres at the base, while the earth above is filled with scattered patches of spawn. Sporidia .001 by .0004-.0005 inch.

1480. *P.* (*Humaria*) *exidiiformis*, B. & Br. *Orbicularis*, luride purpurea; margine elevato inflexo; stipite sursum incrassato; sporidiis late ellipticis, binucleatis; hymenio cribroso.

On silver sand. Cork, Mr. D. Saunders, March 1873. On rotten wood, Stannage Park, C. E. B., March 1873.

Two lines or more wide. Contracting very much when dry. Paraphyses slightly clavate; sporidia  $\cdot 0007$  inch long,  $\cdot 0004$  wide.

1481. *P.* (*Humaria*) *fusispora*, B. Lond. Journ. Bot. 1846; var. *scotica*, Rabenh. Exsicc.

On heathy ground. Berwick, Dr. Johnstone; Menmuir, Rev. M. Anderson, Dec. 22, 1873. On turfy soil, New Pitsligo, Rev. J. Fergusson.

A very pretty species, varying from nearly white to orange or blood-red. Sporidia  $\cdot 001$ – $\cdot 0012$  inch long,  $\cdot 0005$  wide.

1482. *P.* (*Lachnea*) *brunneola*, Desm.

On oak-leaves, Mr. Phillips.

This is very probably the same as *P. fuscescens*, *P.* Desmazières says of his plant that the paraphyses are much longer than the asci, straight, fusiform, pointed, and as wide as the asci. In Mr. Phillips's plant, however, the width of the asci as compared with that of the paraphyses is not exactly the same. The question, perhaps, is whether it should not be referred to *Desmazierella*.

1483. *P.* (*Hymenoscyphæ*) *strobilina*, Fr.

On fir-cones, Scotland, where it appears to be common. The whole cone is sometimes covered with a floccose furfuraceous subiculum.

1484. *P.* (*Mollisia*) *rubella*, P.

On decayed wood with *P. vinosa*. New Pitsligo, Rev. J. Fergusson.

1485. *P.* (*Mollisia*) *Stevensoni*, B. & Br. Minuta; stipite brevissimo sursum incrassato; cupulis subglobosis, saccharinis; sporidiis minutis subcymbæformibus.

On decorticated wood. Glamis, Rev. J. Stevenson.

Minute, subglobose, sugar-coloured, externally minutely granular. Sporidia  $\cdot 0005$  inch long. This is accompanied by white creeping threads, which give off erect branches bearing obovate spores  $\cdot 001$  inch long. Probably a conidiiferous state.

1486. *Helotium tuba*, Fr., b. *ochracea*.

On a heap of decaying vegetables. Menmuir, Rev. M. Anderson, March 1874.

1487. *H. melleum*, B. & Br. Pallide melleum; stipite brevi cylindrico; cupulis planis flexuosis; margine elevato inflexo; ascis elongatis, lanceolatis; sporidiis biseriatis, fusi-formibus, uno latere curvulis, multinucleatis.

On rotten wood. New Pitsligo, Rev. J. Fergusson.

About a line broad; stem half as much high; sporidia  $\cdot 0012$  inch long. Allied to *H. luteolum*.

1488. *H. sublateritium*, B. & Br. Pallide lateritium; stipite brevi cylindrico, subtiliter albo-villoso, glabrescente;



cupulis planis, subtus venosis; margine elevato; ascis linearibus; sporidiis uniseriatis, breviter fusiformibus, binucleatis.

On stems of herbaceous plants. Glamis, Rev. J. Stevenson.

Sporidia  $\cdot 001$  inch long, one fifth as much wide in the centre.

1489. *Psilopezia myrothecioides*, B. & Br. Suborbicularis; margine laciniato tomentosus, pallide flavo; disco viridi-atro; ascis linearibus; sporidiis ellipticis, margine pellucidis.

On *Prunus padus*. New Pitsligo, Rev. J. Fergusson.

Sporidia  $\cdot 0009$  inch long.

One of the most curious circumstances about this species is that some of the asci contain a very delicate spiral thread or line, a structure which Fuckel has observed in some other species.

PLATE II. fig. 5. *a.* plant, *in situ*, of the natural size; *b.* ditto, magnified; *c.* asci; *d.* tip of ascus; *e.* sporidia. All more or less highly magnified.

1490. *Patellaria Fergussoni*, B. & Br. Stipite brevi, sursum incrassato; cupulis planis, extus fuscis, granulosis; hymenio plano vel pulvinato luteo; ascis elongatis; sporidiis filiformibus; paraphysibus capite globoso.

On *Prunus padus*. New Pitsligo, Rev. J. Fergusson.

Sporidia  $\cdot 009$  inch long.

PLATE II. fig. 6. *a.* ascus; *b.* sporidium; *c.* tip of paraphysis; *d.* cells of cup. All highly magnified.

1491. *Ascobolus consociatus*, B. & Br. Cupulis extus rugosis, granulatis, pallide flavis vel albidis; ascis clavatis brevibus; paraphysibus linearibus; sporidiis octonis biseriatis, late fusiformibus.

On the remains of *Sphaeria cupulifera*. Langridge, C. E. B., April 14, 1873.

Cups  $\cdot 003$ – $\cdot 0105$  inch in diameter.

PLATE II. fig. 7. *a.* plant, *in situ*; *b.* single cup; *c.* ascus with paraphyses; *d.* sporidia. All more or less magnified.

1492. *Nectria citrino-aurantia*, Desm. Pl. Crypt. ser. 2, no. 778; Rab. Exs. no. 325.

On willow-twigs. Batheaston, Dec. 1873.

Densely caespitose; sporidia oblong,  $\cdot 0003$ – $\cdot 00035$  inch long.

PLATE II. fig. 8. *a, b.* plant, *in situ*; *c.* asci; *d.* sporidia. All more or less magnified.

1493. *Sphaeria* (*Villosæ*) *membranacea*, B. & Br. Semiimmersa; peritheciis amplis membranaceis, pilis brevibus flexibilibus tectis; sporidiis breviter fusiformibus uniseptatis.

On very rotten wood. Langridge, April 27, 1874, C. E. B.

Walls composed of large cells; sporidia  $\cdot 0015$  inch long,  $\cdot 0007$  wide.

On the same wood with this species, and probably its stylo-sporous state, is a minute *Sphaeronema*, flask-shaped, with a long slender neck and minute globose spores.

PLATE II. fig. 9. *a.* plant, *in situ*; *b.* tissue of perithecia; *c.* ascus; *d.* sporidia. All more or less highly magnified.

\**Venturia alchemilla*, B. & Br. Peritheciis minutis in maculas parvas stellatas congestis; ascis brevibus lanceolatis; sporidiis fusiformibus uniseptatis.

On leaves of *Alchemilla*, on which it appears in the form of little jet-black stellate spots. New Pitsligo, Rev. J. Ferguson, Dec. 31, 1873.

Sporidia shortly fusiform, narrow,  $\cdot 0005$  inch long, uniseptate.

This is *Asteroma*, Grev., *Stigmatea*, Cooke; apparently owing its stellate appearance to the perithecia following the veins of the leaves. Fockel's specimens have the characteristic short hairs.

\**Dothidea betulina*, Fr.

Pycnidia of this species have been sent from the Rev. J. Stevenson, and very closely resemble those of *D. ulmi*, which have also been received from Scotland, and are equally referable to the genus *Piggotia*.

1494. *Hysterium arundinaceum*, Schr., var. *gramineum*; *H. culmigenum*, var.  $\beta$ , Fr. Syst. v. 2. p. 591; Moug. & Nest.

On leaves of grass. Torres, Rev. J. Keith.

This agrees exactly with *H. arundinaceum*, and is the plant of Mougeot and Nestler, and not with *H. culmigenum*, to which the specimen in Cooke's 'Exsiccata' belongs.

1495. *Mucor pruinosus*, B. & Br. Pusillus, niveus; vesiculis globosis, reticulatis; sporis irregularibus.

Covering with a thin white stratum the soil of garden-pots, the plants in which in consequence perished. Sibbertoft, Nov. 1873. Spores  $\cdot 0007$ – $\cdot 0012$  inch long. Some decayed seeds of kidney-beans had been in the soil, and probably were the nidus of the mould.

1496. *Thamnidium Van Tieghemi*, B. & Br. *T. elegans*, Ann. d. Sc. Nat. sér. 5. v. xvii. p. 321.

On cabbage-stalks.

Clearly quite different from *T. elegans* (*Ascophora elegans*, Cld.), as a comparison of Van Tieghem's figure and Corda's

will at once show. *T. elegans* has occurred in this country on fowl's dung.

1497. *Agaricus* (*Collybia*) *Stevensoni*, B. & Br. Pileo semiovato, obtuso, viscido, pallide luteo hic illic e visco maculato; stipite tenui fibrilloso sursum pulverulento extus intusque rufulo radicato; lamellis latis adnatis, dente decurrentibus distantibus candidis.

Glamis, Rev. J. Stevenson, Aug. Pileus  $\frac{1}{2}$  inch across and high; stem  $1\frac{1}{2}$  inch high, scarce a line thick, composed of fibres.

Allied to *Ag. ventricosus*, but differing in its slender almost solid stem, viscid semiovate pileus, and very broad, adnate, somewhat ventricose plane gills.

1498. *Agaricus* (*Hypholoma*) *silaceus*, P.

Glamis, Rev. J. Stevenson.

Pileus viscid, bright orange rufous; stem 4 inches high, at length hollow, solid and slightly swollen at the base. Smell resembling that of meal. Spores pale purple-brown.

1499. *Cortinarius* (*Inoloma*) *traganus*, Fr., var. *fnitimus*, Weinm. p. 155.

Torres, Rev. J. Keith.

Smell not at all that of the typical form, but pleasant though peculiar, resembling that of gum just beginning to ferment. Pileus silky, at length smooth, lilac, as is the stem, which is yellowish and mottled within, but not saffron-coloured nor brown.

This peculiar form is the more interesting as it has not been met with in Sweden.

1500. *Eustegia arundinacea*, Fr. *Peziza Kneiffii*, Wallr.

New Pitsligo, Rev. J. Fergusson.

Quite different from a form of *Peziza fusca*, which is named in some herbaria *P. Kneiffii*.

[To be continued.]

III.—*Descriptions of two new Species of Crustacea from New Zealand.* By Captain F. W. HUTTON, C.M.Z.S.

*Sesarma pentagona.*

Carapace subquadrate, smooth, broader than long; anterior lateral margin with two teeth; front nearly vertical, with four rounded projections; lateral regions obliquely striated; a

pentagonal mark in the centre, the apex prolonged to the front, which it divides. Area on each side of the mouth below with moniliform transverse striae. Arms trigonal, striated on the outside; hands smooth outside, and with a few scattered granules inside; fingers smooth. Legs with the third joint very broad, compressed, acute above, and armed with a single tooth at the apex, smooth; outer joints and claws tomentose. Length .67 inch; ratio of length to breadth 1:1.27.

A single specimen in the Colonial Museum, Wellington, locality not stated.

*Palinurus Edwardsii.*

*Male.* Carapace beaked, armed with spines and large oval depressed tubercles separated by rows of short hairs. Beak small, compressed, curved upward, and with two small spines at its base; spines on each side of the beak compressed and smooth. Abdomen transversely sulcated, and covered with flat tubercles, each segment with a row of short hairs on its posterior margin; a single tooth on the posterior margin of the lateral lobes of the abdominal segments. Anterior legs with a strong spine on the inferior margin of the second and third joints, none on the penultimate joint; the superior margin of the distal extremity of the third joint of the last four pairs of legs armed with two spines, a smaller one in front of the larger. Length from beak to end of telson 9.5 inches.

*Colour.* Carapace and antennæ dark brownish purple; abdomen the same, marbled with yellow; legs and caudal appendages reddish orange, more or less marked with purple.

In the *female* the beak is wanting, and there is a spine on the inferior margin of the distal extremity of the penultimate joint of the last pair of legs, making it subchelate.

*Locality.* Otago Heads, common.

This species differs from *P. Lalandii* in its much smaller size, in the shape of the beak (which is straight and conical in *P. Lalandii*), in having no spine on the penultimate joint of the anterior legs, and in having a second small spine at the distal extremity of the third joint of the last four pairs of legs. I have named it in honour of M. Alphonse Milne-Edwards, who has done so much to increase our knowledge of New-Zealand carcinology.

## IV.—Note on a new Provisional Genus of Carboniferous Polyzoa. By R. ETHERIDGE, Jun., F.G.S.

[Plate IV. B. figs. 1-4.]

## HYPHASMOPORA, gen. nov.\*

*Polyzoarium* dendroid (?), calcareous, composed of small cylindrical stems, often bifurcating. Cell-depressions arranged in linear longitudinal series, more or less separated from one another by a cancellated network or reticulation, forming the interstitial surface, and predominating at one part of the polyzoarium more than at others, presenting a longitudinal zone, devoid, or nearly so, of cell-depressions. The interstitial network consists of a series of irregularly formed pores.

The fragments to which I have provisionally applied the above name consist of small occasionally bifurcating stems, with nearly the whole of the surface occupied by six or more longitudinal rows or series of pyriform and (for the size of the organism) large cell-depressions, subalternating one with the other. The intermediate and remaining portions of the interstitial surface, between each longitudinal series and each individual cell, are occupied by small, irregularly formed, but generally elongate pores, forming a reticulated or cancellated network. This is more particularly the case over one part of the surface, generally devoid of cell-depressions, but occasionally with a single row running up the centre, or one or two irregularly placed. This space is bounded by the two lateral rows or series of cell-depressions, one occupying each side of the stem. At times the poral reticulation between the longitudinal series of cell-depressions is almost absent, or considerably reduced, when, the lateral prominent margins of two contiguous series uniting, a dividing ridge or keel is formed, which, when viewed transversely, gives to the cross section of the stem a slightly multiangular appearance. The cell-depressions lead upwards and inwards to the true cell-aperture or orifice, considerably smaller than the larger opening, and apparently oval in outline.

The cells are at first vertical, and then curve obliquely upwards and outwards to the surface, where they open at right angles to the imaginary axis, the pyriform depression in which

\* ἵφασμα, tissue or web; πόρος, a passage or pore. [The specimens are in the collection of the Geological Survey of Scotland; and this description is published by permission of the Director-General of the Geological Survey.]

the orifice is placed having a prominent margin, projecting a little from the surface of the stem at its dorsal side, whilst the true orifice itself projects at its lower margin. At the point at which the cells bend from the perpendicular to the oblique angle at which they pass to the surface, one of the walls is much constricted, that nearest the external surface.

I have never seen this pretty coralline in any other condition than such fragments as are here figured; but a specimen has lately come under my notice in which there appears to be the remains of a lateral branch or dissepiment, after the manner of *Polypora* or *Fenestella*; but on this point I am in doubt. Under these circumstances it would be premature to state whether the habit was simply dendroid, with free stems and branches, or reticulate.

I submitted specimens of the simple bifurcating stems to Mr. Busk, who very kindly informed me that in such a condition they resembled the genus *Vincularia*, DeFrance, but that none of its hitherto described species were so pitted or reticulated, and that, as the openings of the cells do not appear to be placed on all sides of the stems, as they are invariably in *Vincularia*, it is probably the type of a new genus, perhaps allied to the latter.

As I am unable to meet with any generic diagnosis which would include the form, I have adopted, provisionally at least, the foregoing name for its reception, and for a specific designation would associate with it the name of Mr. Busk, to whose kindness I am indebted for much information on fossil Polyzoa. In addition to this species, there are one or two others in my possession which will perhaps come under this genus.

*Hyphasmopora Buskii*, sp. nov.

Cell-depressions pyriform, subalternating with one another, narrowing towards their ventral margins, expanding above, where they project a little from the surface of the polyzoarium, arranged in about six linear series, the individual depressions of each row separated from one another vertically by the interstitial reticulation; laterally the margins of contiguous rows sometimes unite, forming dividing ridges or keels; cell-orifice round, placed within the cell-depression at its upper extremity. The interstitial network encloses a series of irregular poral openings. The sides are occupied by the two lateral rows of cell-depressions. The reverse, over which the reticulation attains its greatest development, sometimes has a single row of large cell-depressions placed along the median line, at various distances from one another.

*Localities.* Limekilns Old Quarry, near Limekilns House, near East Kilbride, from shale between the first and second limestones of the Calderwood series, Lower Carboniferous Limestone group; Calderside Old Quarry, near East Kilbride, from a similar geological horizon: collected by Mr. James Bennie. Mousewater, opposite Lambcath, near Wilsontown, from shale between two thin limestones of the Lower Carboniferous Limestone group; quarry near Hillhead, near Wilsontown, from shale over the Guildhouse Limestone, Lower Carboniferous Limestone group: collected by Mr. A. Maccochie (collection of the Geological Survey of Scotland).

## EXPLANATION OF PLATE IV. B.

[The figures are all considerably enlarged.]

- Fig. 1.* *Hyphasmopora Buskii*, a bifurcating stem, showing the longitudinal series of cell-depressions, with a peculiar swelling of the interstitial surface.
- Fig. 2.* The same. In this specimen are visible a few of the true cell-orifices.
- Fig. 3.* The same, showing the opposite face or interstitial zone, with its single row of cell-depressions.
- Fig. 4.* The same, a similar specimen to the last, but the branches with a wider angle of bifurcation.

V.—On the Madagascar River-Hog (*Potamochoærus*), and on the Skulls of the three Species of the Genus. By Dr. J. E. GRAY, F.R.S. &c.

[Plate IV. A.]

FLACOURT, in his 'History of Madagascar,' notices a wild boar in that island; and D'Aubenton, in his additions to Buffon's 'Hist. Nat.' xiv. p. 390, describes a dry head of a "sanglier de Madagascar" in the Cabinet of Paris, which he says is that of a "cochon de Siam;" but by his description it is evidently that of a river-hog (*Potamochoærus*). I noticed it as a species of that genus in 'Proc. Zool. Soc.' 1868, p. 38, more especially as Mr. Sclater informed me that there was a living specimen of the animal from Madagascar in the Garden of Plants at Paris; and in the 'Catalogue of Carnivorous, Pachydermatous, and Edentate Animals in the British Museum,' 1869, p. 344, I named it *Potamochoærus madagascariensis*, observing that I was not aware of any specimen in this country. I now find, which had escaped me

when I gave the name *madagascariensis* to this species, that M. Grandidier, in the 'Revue et Magasin de Zoologie,' 1867, tome xix. p. 318, had named the wild pig from Madagascar *Potamocharus Edwardsii*; and I gladly adopt his name, as it was published previously.

All M. Grandidier says respecting this species is:—"P. *Edwardsii* (nob.). Nom malgache Lambou. De la côte S.O. (Moroundava). Roux-cannelle, crinière blanchâtre, épaisse; membres d'un brun foncé. Taille petite. Les soies sont très-longues; les oreilles sont dépourvues de pinceau de poils à leurs extrémités; joues noires, encadrées de longues soies blanches."

The British Museum purchased of Mr. Edward Bartlett a young specimen of a wild pig from Ambodiaque, west of Tananarivo, the capital of Madagascar, which he names "*Potamocharus madagascariensis*." I have compared with this specimen a young bosch-vark (*Potamocharus africanus*) in the British Museum from South Africa, and I can find very little difference between it and the much younger specimen from Madagascar received from Mr. Bartlett.

The latter has the longer white hairs on the chine, which are black at the base and form a black spot between the ends of the bladebones; and it agrees in the general colouring, and only differs from the larger specimen in having the short black stripes on the sides rather less indistinct, evidently the remains of the dark spots with which the very young bosch-varks are marked.

The skull of this specimen, which is probably that of a female, has the impressions on the side of the nose only slightly defined, and the zygomatic arch is thin and with a rounded outline beneath. The nose is slender and rather flat, and rounded on the sides of the upper edge, but was in too young a state to afford any specific characters.

I was inclined to believe it to be the young of the continental species. I had not seen an adult skin from Madagascar; and unfortunately the skull was in too young a state to show the characters of the species. But Mr. Edward Gerrard, jun., has since brought to the Museum the skull of an adult male river-hog (*Potamocharus*) from Tamatava forest in Madagascar, which proves that the Madagascar animal is a very distinct species, characterized by the narrowness of the nose, with a rounded upper edge, the width of the skull at the zygomatic arch, and the angular outline of the lower edge of this arch, and by the situation of the aperture for the vessel in the lower jaw, which seems to be a permanent character, as it is uniform



in the six or eight skulls of *P. africanus* and *P. porcus* in the British Museum.

The three species of this genus may be thus characterized by their skulls:—

\* *Head and face varied with blackish; fur elongate, harsh. Crest of the sheath of the upper canines elongate in the male.*

*P. africanus.* Nose of skull broad, flat at top, and keeled at sides; lower edge of zygomatic arch regularly curved.  
South and Central Africa.

*P. Edwardsii.* Nose of skull narrow, rounded at top and upper margin of sides; lower edge of zygomatic arch sub-angular in the middle. (Plate IV. A.)  
Madagascar.

\*\* *Head and face varied with white; dorsal mane white. Crest of the sheath of the upper canines of the male shorter, broad.*

*P. porcus.* Nose of skull broad, flat at top, and keeled on the upper margin.  
West coast of Africa.

They may be further characterized as follows:—

\* *The zygomatic arch swollen out, with an irregularly rounded lower edge; the impression on the side of the forehead broad and truncated behind, with a perpendicular edge just before the orbit; the lower jaw with the perforation for the passage of the vessel under the space between the second and third lower grinders; the front of the upper part of the nose flat, broad, rather keeled on the sides.*

*Potamochoærus porcus*, Gray, Hand-Cat. B.M. tab. 23. fig. 1, ♂.

The lobe over the sheath of the upper canines of the male truncated, spreading outwards, and not reaching the callosity of the lateral ridge on the side of the nose.

*Potamochoærus africanus*, Gray, Hand-Cat. B.M. tab. 23.  
fig. 2, ♂.

The lobe over the sheath of the upper canines of the male elongate, adpressed to and reaching the callosity of the lateral ridge on the side of the nose.

\*\* The zygomatic arch swollen out, broad in the middle, and with a produced subangular lower edge; the impression on the side of the forehead rather narrow, obliquely truncated, produced above so as to have an oblique edge, extending forward in front of the orbit; lower jaw with a perforation for the passage of the vessel under the space between the first and second lower grinders; the front of the upper part of the nose narrow, flattish, rounded on the sides.

*Potamochoerus Edwardsii*.

The lobe over the sheath of the upper canines elongate, adpressed, and reaching the callosity of the lateral ridge on the side of the nose.

The lobe over the base of the sheath of the canines in the males is elongate and adpressed to the sides of the nose, as in *P. africanus*, and not short and diverging outwards as in *P. porcus*. The skull has a much slenderer nose, is much lower behind, and has a narrower occipital end than in either of the continental species, in both of which it is high and broad behind and has a broad square nose.

The skulls of the female river-hogs (*Potamochoerus*) only have a sharp ridge across the base of the sheath of the canines; and the sides of the nose are smooth, and not callous and warty in the middle part as in the males; and the impressions on the sides of the forehead just before the eyes are not so deep and well marked as in the skulls of the males; and the lobe of the maxillary bone forming the front portion of the maxillary arch is broader than in the males.

The lobe over the base of the canines of the males of *P. porcus* is compressed, callous, and rugose at the ends. It seems to vary in shape: in two skulls in the Museum from the Cameroons and Gaboon it is moderately broad, with a rounded outer edge and a convex rounded outer surface; and in one from West Africa (believed to be from the Niger) it is flattened, broader, and with a much flatter surface. The lobes over the base of the canines of the males of *P. africanus* are longer and broader; one has a distinct keel on the hinder part of the outer side; and the other has but very slight indications of such a keel and is rounded.

VI.—On new Species of Bivalve Mollusca found at Cumana, Venezuela. By R. J. LECHMERE GUPPY, F.L.S., F.G.S., &c.

[Plate VII. figs. 1 & 2.]

ONE of the shells now to be described is a large and fine species of *Venus*. If I mistake not, this species has been regarded by some as the *V. crenulata* of Chemnitz; but the shell which I have for years considered to be that species is a smaller and very different one.

The other shell is a *Mactra*, not belonging to the typical group of that genus, but, on the contrary, somewhat of an aberrant form. It is a large and interesting species.

The recent, not less than the fossil, shell-fauna of Cumana is very interesting. Among the recent shells are several which are by no means common in the West Indies—as, for instance, the true *Persona reticularis* (Linn.), which, though nearly allied to, must not be confounded with the *P. clathrata* of Madagascar nor with the fossil *P. simillima* of the West-Indian Miocene. *Dipsacus glabratus* occurs at Cumana; and I have also from that place an undetermined species of *Fusus* (which resembles young shells of *Fasciolaria gigantea*, except that it has a longer canal), and also the following—*Solarium tessellatum*, *Phos guadelupensis*, *Venus flexuosa*, *Culyptrava auriculata* (of which apparently there is a good figure in the large edition of Cuvier's 'Règne Animal,' pl. 48. f. 4, under the name of *C. Cuvieri*, Desh.), *Oliva reticularis* (several forms), and *O. monilifera*, Reeve (? = *O. mutica*, Say, = *nitidula*).

*Venus superba*, n. sp. Pl. VII. fig. 2.

Ovate, slightly subtrigonal, a little inequilateral, ventricose; anteriorly produced and rounded; posteriorly produced and subangulate; umbones closely approximate; lunule large, striated with irregular diverging lamellæ, distinctly defined by a sharp groove; posterior dorsal area large, striate, not distinctly defined. Valves marked with numerous irregular angulate streaks of chestnut or brown, and adorned with numerous concentric crenate ribs, which are rather more distant, thinner, and more distinctly crenate near the anterior and posterior margins; on the disk the ribs are square, flattened, and polished, and the crenation is less marked. Length 70 millims., height 55, thickness about 45.

*Mactra anserina*, n. sp. Pl. VII. fig. 1.

Oval, compressed, subequilateral, gaping widely posteriorly; *Ann. & Mag. N. Hist. Ser. 4. Vol. xv.* 4

anteriorly somewhat produced and subangular; posteriorly high, with a decided obtuse angle formed by a low keel running from the umbo, on the upper and posterior side of which keel the shell is covered with a black epidermis. Valves flattened, white, rather fragile, marked with concentric striæ of growth, which are worn smooth on the disk and umbones, but towards the ventral margin are covered with a yellowish-brown wrinkled epidermis. Length 85 millims., height 60, thickness 30.

Closely allied to *M. fragilis*, which, indeed, appears to have been confounded with it. The details of the hinge are somewhat similar to those of the hinge of *Hemimactra gigantea*; but the postearinal area resembles that of *Schizodesma*. The latter feature is much developed in our shell, and is remarkable for its black epidermis, that of the other portions of the shell being of a light brown.

VII.—*Notice of some Marine Shells found on the Shores of Trinidad.* By R. J. LECHMERE GUPPY, F.L.S., F.G.S., &c.

[Plate VII. figs. 3 & 4.]

*Purpura trinitatensis*, Guppy.

A solid, ovate, yellowish, subimate shell, adorned with numerous rounded spiral ridges, which are crossed by fine imbricating striæ: whorls about 6, with four spiral rows of obtuse elongated tubercles, of which the two upper rows are much the largest, the superior one forming the angle of the whorls: suture hidden by a row of stout curved and reflected lamellæ, of which there are about three above each of the tubercles on the angle of the whorl: spire conic, sharp: mouth pink within, and often ornamented with two or three more or less interrupted spiral red or chestnut lines corresponding to the external rows of tubercles: aperture oval, with a small and decided posterior canal forming the successive sutural lamellæ; anterior canal open and a little reflected: pillar-lip smooth, flattened or hollowed out, bright pink; outer lip denticulate, obsolete striate within. Height 40 millims., greatest breadth 27, longest diameter of aperture 26.

*Hab.* Gulf of Paria.

A species somewhat resembling *P. mancinella*, but with a sharper spire and a more decided striation. The sutural lamellæ are well developed, like those of *P. coronata*. There is a strong ridge round the base,

*Cardium eburniferum*, Guppy. Pl. VII. fig. 3.

Shell a little angularly suboval, moderately tumid: externally marked with irregular orange-brown spots, and adorned with thirty-five narrow imbricated ribs closely covered towards the margins of the shell with numerous porcellaneous semitubular tubercles, which are thicker anteriorly; posterior edge nearly straight, strongly serrate. Hinge-teeth  $\frac{1-1-1}{1-1-1}$ , strong. Interior salmon-colour, growing white towards the strongly dentate margins, which are yellowish. Height 52 millims., length 45, thickness 40.

*Hab.* South coast of Trinidad (*T. W. Carr*). Found abundantly at Grenada.

*Cardium haitense*, Sowerby, Quart. Journ. Geol. Soc.  
vol. vi. p. 52, pl. x. f. 11.

An oblique subovate shell, with 20-24 radiating, nodose, rather square ribs wider than their finely crenate interstices. Allied to *C. subovale*, Brod.

This was originally described by Sowerby as a fossil from Haiti; but I have dredged two small examples of it in the Gulf of Paria.

*Arca centrata*, Guppy, Proc. Scientific Assoc. of Trinidad,  
p. 175 (Dec. 1867). Pl. VII. fig. 4.

This species was described as a fossil; but I have since ascertained that it is likewise living on our coasts, having been collected by myself on the shores of the Gulf of Paria, and by Mr. Carr on the south coast of Trinidad. Its umbones are often pink or red, which colour is visible inside as well as outside; and the shell has a hairy epidermis, generally worn off at the umbones. Height 17 millims., length 24.

The following is the original description:—"Transversely subrhomboidal, with a strong wide carination running from the umbo to the posterior angle; ornamented with many (36-38) squamosely nodose radiating ribs, each with a fine subsidiary thread-like rib in the narrow interstice; anterior margin short, rounded; posterior margin strongly sinuate, angulate above with the hinge-line, and forming a more rounded angle with the strongly crenate lower margin. Hinge-teeth small in the middle of the straight hinge, but becoming larger and diverging considerably towards the angles; ligamental area more or less grooved, especially anteriorly."

*Thracia dissimilis.*

Ovate-oblong, compressed, white, roughened by numerous fine granules, which are generally arranged in lines radiating from the umbo; transversely excentrically plaited; anteriorly rounded; posteriorly vertically truncate, with a keel (most prominent on the smaller valve) running from the umbo to the lower posterior angle. Height 27 millims., length 40, thickness 15.

This is nearly allied to *T. plicata*, which Reeve (Conch. Icon. *Thracia*, 7) considered it to be. Our shell is rather intermediate between *T. plicata* and *T. magnifica*, differing from the former in ornamentation and general shape. On a tablet in the British Museum the name *dissimilis* is applied to our species; but I have not been able to find any authority for that name, which I adopt for the shell.

The animal is furnished with two long siphons, separate for the whole of their length and coarsely fringed. The epidermis along the posterior margin extends beyond the shell and covers the bases of the siphons.

## EXPLANATION OF PLATE VII.

[All the figures are of the natural size.]

*Fig. 1. Mactra anserina*, right valve. Cumana, Venezuela.

*Fig. 2. Venus superba*, right valve. Cumana, Venezuela.

*Fig. 3. Cardium eburniferum*, right valve. South coast, Trinidad.

*Fig. 4 a. Arca centrota*, right valve, interior.

*Fig. 4 b.* The same, right valve of a large specimen, exterior.

Port-of-Spain, Trinidad, Sept. 1874.

VIII.—Notes on the Palæozoic Bivalved Entomostraca.  
No. XI. Some Carboniferous Ostracoda from Russia.  
By Prof. T. RUPERT JONES, F.R.S., F.G.S., &c., and  
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[Plate VI.]

IN the seventh livraison of the first volume of his 'Lethæa Rossica' \* M. d'Eichwald figures and describes twenty species of Palæozoic Entomostraca, twelve of which are from the

\* We refer to the French edition, published at Stuttgart in 1860.

Carboniferous rocks of Russia. Most of these species had been previously noticed by him, though not figured, in the 'Bulletin Soc. Imp. Nat. Moscou,' année 1857, p. 198.

M. d'Eichwald's specimens are from the Carboniferous Limestone of Borowitschi, in the Government of Novogorod; from Carboniferous Limestone on the right bank of the Serena, near Goroditz, in the district of Kozel, in the Government of Kalouga; from Carboniferous Limestone on the river Tscherepete, near Tschernischine, in the district of Likhwine, in the Government of Kalouga; from the Carboniferous Dolomite of Sterlitamak, in the Government of Orenburg; from the *Cytherina*-Limestone near the village of Filimonoff, on the river Oupa, in the Government of Toula; and from the Carboniferous Shale of Sloboda, also in the Government of Toula.

From these materials D'Eichwald describes and figures the following species:—

- Bevrichia gibberosa*. *D'Eichwald*, Bull. S. I. N. Mosc. 1857, xxx. ii. p. 312; Leth. Ross. i. v. 1859, p. 309, vii. 1860, p. 1349, pl. 52. f. 11.
- *colliculus*. *D'Eichwald*, Bull. S. I. N. Mosc. 1857, xxx. ii. p. 313; Leth. Ross. i. v. 1859, p. 309, vii. 1860, p. 1348, pl. 52. f. 1.
- *umbonata*. *D'Eichwald*, Bull. S. I. N. Mosc. 1857, xxx. ii. p. 312; Leth. Ross. i. v. 1859, p. 309, vii. 1860, p. 1347, pl. 52. f. 10. This is a *Kirkbya*.
- *striolata*. *D'Eichwald*, Bull. S. I. N. Mosc. 1857, xxx. ii. p. 312; Leth. Ross. i. v. 1859, p. 309, vii. 1860, p. 1348, pl. 52. f. 14. This is a *Kirkbya*.
- Leperditia microphthalmia*. *D'Eichwald*, *Cypridina*, Bull. S. I. N. Mosc. 1857, xxx. ii. p. 310; *Leperditia*, Leth. Ross. i. vii. 1860, p. 1336. Possibly a variety of *L. Okeni*.
- Bairdia Qualeni*. *D'Eichwald*, Bull. S. I. N. Mosc. 1857, xxx. ii. p. 311; Leth. Ross. i. v. 1859, p. 309, vii. 1860, p. 1339, pl. 52. f. 4.
- *levigata*. *D'Eichwald*, *Cypridina*, Bull. S. I. N. Mosc. 1857, xxx. ii. p. 310; Leth. Ross. i. v. 1859, p. 309; *Bairdia*, Leth. Ross. i. vii. 1860, p. 1342, pl. 52. f. 5; and var. *nigrescens*. Both are *Leperditia*, and probably varieties of *L. Okeni*.
- *æquatis*. *D'Eichwald*, Bull. S. I. N. Mosc. 1857, xxx. ii. p. 311; Leth. Ross. i. v. 1859, p. 309, vii. 1860, p. 1340, pl. 52. f. 6.
- *excisa*. *D'Eichwald*, Bull. S. I. N. Mosc. 1857, xxx. ii. p. 311; Leth. Ross. i. v. 1859, p. 309, vii. 1860, p. 1342, pl. 52. f. 8. Possibly *Cythere* (?) *bilobata* (Münster).
- *distracta*. *D'Eichwald*, Bull. S. I. N. Mosc. 1857, xxx. ii. p. 311; Leth. Ross. i. vii. 1860, p. 1341, pl. 52. f. 12. Very similar to *Bairdia mucronata*, Reuss.
- *curta*. McCoy, *D'Eichwald*, Bull. S. I. N. Mosc. 1857, xxx. ii. p. 311; Leth. Ross. i. v. 1859, p. 309, vii. 1860, p. 1338, pl. 52. f. 17. and var. f. 18. *B. ampla*, *plebeia*, and varieties.

Judging from M. d'Eichwald's published figures, some of the above species may be more appropriately placed in other

genera. *Beprichia umbonata* and *B. striolata* seem to belong to *Kirkbya*; and *Bairdia levigata* is a *Leperditia*.

Soon after the publication of the above-named work we were kindly favoured by M. d'Eichwald with a series of Russian specimens; and these have enabled us to arrive at a better understanding on some points of his Carboniferous species. We have also some other specimens, brought from Russia by the late Sir Roderick I. Murchison. Out of the eight species and their varieties (four) which we have identified among our Russian specimens, four have already been described as Carboniferous, two as Permian forms, one as Silurian, and four are new. Three or four named by M. d'Eichwald we relegate to other authors. There remain six or seven of M. d'Eichwald's Carboniferous species which we have seen in figures only.

We figure the best of our Russian specimens in Plate VI.; and the following observations will assist in defining the species.

1 & 1\*. *Leperditia Okeni* (Von Münster †), and var. *inornata* (M'Coy). Pl. VI. figs. 1 & 2.

*Bairdia levigata*, var. *nigrescens*, D'Eichwald, Leth. Ross. i. vii. p. 1342, pl. 52. fig. 5.

This species, so common in the Carboniferous formations of Britain, Europe, and Nova Scotia, occurs in great numbers in a piece of hard, dark-grey, saccharoid limestone, labelled "*Bairdia levigata*, var. *nigrescens*, village of Phillineonowa, in the Government of Toulou." The specimens, rather small, are all single valves, and of a blackish colour. The general contour of the carapace is nearly that of the typical *L. Okeni*. The eye-spot is not distinguishable. *Primitia Eichwaldi*, Corals, and Brachiopods are associated.

From near Likhwine, in the same Government, we have a minute specimen of this species, with a well-marked eye-spot and a slight marginal rim (fig. 2). In the former feature it agrees with M. d'Eichwald's figure of his "*Bairdia levigata*." From the same locality, in a piece of soft yellow limestone, other rather larger specimens occur, which we also refer to this species. They differ in having the carapace-valves less oblique than is usual with *L. Okeni*, thus having a nearly semicircular hinder end. These might without much difficulty be mistaken for a *Cythere*, and indeed do occur in a piece labelled "*Bairdia excisa*." This variety is not unusual

† Ann. & Mag. Nat. Hist. ser. 3, vol. xv. p. 406, pl. 20. figs. 1-3.



in the Carboniferous rocks of Scotland and Ireland; and may be regarded as *L. Okeni*, var. INORNATA (M'Coy).

M. d'Eichwald's figure of "*Bairdia levigata*" approximates to that of a *Leperditia*, and shows also the characteristic eye-spot. *L. microphthalma*, D'Eichw., also appears to be related to *L. Okeni* as a small variety.

1\*\*. *Leperditia Okeni*, var. *obliqua*, nov. Pl. VI. fig. 3.

With the typical *L. Okeni* from Phillineonowa we find a few specimens of a small *Leperditia* having a relatively short hinge-line, a long sloping posterior region, and a full ventral curve. This is near *L. Okeni*, var. *acuta* (Ann. & Mag. N. H. ser. 3, vol. xv. p. 406, pl. 20. fig. 4); but it has a shorter hinge-line. In outline it approaches both *L. Hisingeri* and *L. Williensis* of Fr. Schmidt\*, but agrees with neither. We propose to name this form var. OBLIQUA, as the greatest length is along a line much higher in front than behind.

2. *Beyrichia intermedia*, Jones & Holl. Pl. VI. fig. 11.

Length  $\frac{1}{40}$  inch, height  $\frac{1}{30}$  inch. A minute, subovate, smooth *Beyrichia*, with a nearly semicircular ventral border and a deep subcentral sulcus, rather posteriorly placed; this sulcus cuts the valve vertically, and extends from the dorsal border to less than halfway across the valve; another, but faint, indentation exists near the smaller (anterior) extremity.

In soft yellow limestone from near Likhwine, in the Government of Toula.

This is undistinguishable from *B. intermedia*, J. & H.†, from the Upper Silurian rocks of Malvern, except that its slightly greater length gives it a rather more oval outline.

3. *Primitia Eichwaldi*, sp. n. Pl. VI. fig. 12, a, b.

Associated with the *Leperditia* of Phillineonowa we have found some specimens of an Entomostracan corresponding with the description of *Primitia* given in the 'Annals,' ser. 3, 1865, vol. xvi. p. 415, except that it has a reticulate and slightly wrinkled ornament.

It is  $\frac{1}{28}$  inch long,  $\frac{1}{50}$  inch high; has elongate, oblong, flatly convex valves, with a straight dorsal border, a vertical sulcus in the posterior half, narrow above and broad below,

\* "Ueber die russischen silurischen Leperditien," Mém. Acad. Imp. Sc. St.-Pétersb. ser. 7, vol. xxi. 1873.

† Ann. & Mag. N. H. ser. 4, 1869, vol. iii. p. 218, pl. 15. f. 7.

and a slight rim bounding the free margin: the surface, in unworn examples, is reticulately ornamented, and is usually marked with numerous rather fine longitudinal wrinkles, due to the thickening of the longitudinal walls of the network.

The Upper-Silurian *P. variolata*, J. & H. *op. cit.* p. 418, pl. 13. f. 6, is a near ally; but is shorter, has its sulcus more central, and shows only a pitted ornament.

Some small bivalve carapaces from the Carboniferous strata of West Scotland †, and others from Shropshire, are allied to the form under notice, having suboblong outline, longitudinal wrinkles (stronger), and some fine reticulation; but the sulcus is contracted to a central *pit*, such as is found in some *Primitia*. We have also a small smooth form from Lanarkshire.

#### 4. *Bairdia æqualis*, D'Eichwald. Pl. VI. fig. 4.

We identify a specimen from the yellow limestone of Likhwine with this species. It is  $\frac{1}{2\frac{1}{2}}$  inch long,  $\frac{1}{4\frac{1}{4}}$  inch high, smooth, swollen, of a subtrapezoidal outline, with the posterior extremity blunt, and with a strong dorsal and ventral overlap.

#### 5. *Bairdia ampla*, Reuss. Pl. VI. fig. 5.

Two very fine examples of a *Bairdia* sent us by M. d'Eichwald as *B. curta*, from Sloboda, in the Government of Toula, appear to us to belong to *B. ampla*, Reuss, known in both the Carboniferous and Permian formations.

The perfect shape of *B. curta*, M'Coy, has been given by one of us in plate 61. fig. 1, 'Monthly Microsc. Journ.' vol. iv. 1870.

#### 6\*. *Bairdia plebeia*, Reuss, var. *rhombica*, Jones. Pl. VI. fig. 6.

Included with the specimens of the last species is a single example of what seems to be, if not a distinct species, a rhombic variety of *B. plebeia*, described and figured in the 'Trans. Tyneside Nat. Field-Club,' vol. iv. 1859, p. 42, pl. 11. figs. 10, 11, 12. *B. plebeia* is common in both the Carboniferous and Permian formations; var. *rhombica* is Permian also.

† "*Kirkbya scotica*," J. & K. MS., 'Trans. Geol. Soc. Glasgow,' vol. iii. Suppl. Carb. Foss. p. 28. Unless specimens with concentric longitudinal ribs occur, this species will have to be allocated to *Primitia*.

6\*\*. *Bairdia plebeia*, Reuss, var. *mundu*, nov.  
Pl. VI. fig. 7.

We have one specimen of another variety of *B. plebeia* from the yellow limestone of Likhwine. It is rather more oblong than the usual form of the Permian *B. plebeia*, and its posterior angle is less developed. See Reuss, "Ueber Entom." &c., Jahresb. Wetterauer Ges. 1854, p. 67, f. 5.

7. *Cythere* (*Potamocypris*?) *bilobata* (Von Münster).  
Pl. VI. figs. 8, 9, 10.

*Bairdia excisa* (?), D'Eichwald, Leth. Ross. i. vii. p. 1342, pl. 52. f. 8.

We have three specimens of this species from the yellow limestone near Likhwine. They were sent to us by D'Eichwald labelled as "*Bairdia excisa*." They nevertheless undoubtedly belong to Von Münster's "*Cythere* (?) *bilobata*"†, to which we now refer them.

D'Eichwald's figures show a much greater constriction on the subconcave border than we find in our specimens.

The recent *Potamocypris fulva*, G. S. Brady (Ann. & Mag. N. H. ser. 4, iii. pl. 18. figs. 1-4, and Nat. Hist. Transact. Northumb. and Durham, iii. p. 366), presents an external appearance remarkably similar to that of *Cythere* (?) *bilobata*.

8. *Cytherella Murchisoniana*, sp. n. Pl. VI. fig. 13, *a, b*,  
fig. 14, *a-c*.

In a fragment of brown crystalline limestone, from a locality 30 wersts east of Bugulina, collected by the late Sir Roderick Murchison, we have numerous specimens of a small Entomostracan, which probably belongs to the genus *Cytherella*.

It is  $\frac{1}{20}$  inch long, and half as high. The carapace-valves (always separate) are oblong in outline, with the dorsal and ventral borders nearly parallel; the ends are rounded; the posterior extremity is most obtuse; and from the region adjoining it the carapace contracts so as to give rather a wedge-shaped dorsal aspect. In casts a slight constriction crosses the valves near the posterior third (fig. 14, *b*). The shell is thick, and the surface apparently smooth.

† Ann. & Mag. N. H. ser. 3, vol. xv. p. 409, pl. 20. f. 10. This species, not uncommon in some Carboniferous rocks of Britain and Europe, was described by us (*loc. cit.*) as a *Cythere*: it is most probably either a *Potamocypris* or a *Bairdia*.

## List of the Carboniferous Ostracoda of Russia.

- Beyrichia gibberosa*, D'Eichw. Sloboda.  
 — *colliculus*, D'Eichw. Tschernischine.  
 — *intermedia*, Jones & Holl. Tschernischine.  
*Kirkbya umbonata* (D'Eichw.). Sloboda.  
 — *striolata* (D'Eichw.). Sloboda.  
*Primitia Eichwaldi*, Jones & Kirkby. Phillineonowa.  
*Leperditia Okeni* (Von Münster). Phillineonowa, Sloboda.  
 — —, var. *inornata* (M' Coy). Tschernischine.  
 — —, var. *obliqua*, J. & K. Phillineonowa.  
 — —, var. *microphthalma*, D'Eichw. Goroditz and Sloboda.  
*Cythere* (?) *bilobata* (Von Münster). Tschernischine and Sloboda.  
*Bairdia excisa* (?), D'Eichw. Tschernischine and Sloboda.  
 — *ampla*, Reuss. Sloboda\*.  
 — *plebeia*, Reuss, var. *rhombica*, Jones. Sloboda.  
 — —, var. *munda*, J. & K. Tschernischine.  
 — *æqualis*, D'Eichw. Sloboda.  
 — *distracta*, D'Eichw. (= ? mucronata, Reuss). Borowitschi and Goroditz.  
 — *Qualeni*, D'Eichw. Sterlitamak.  
*Cytherella Murchisoniana*, J. & K. Near Bugulina.

## EXPLANATION OF PLATE VI.

[All the figures, except fig. 12 b, are magnified 20 diameters.]

- Fig. 1. *Leperditia Okeni* (Von Münster): right valve of small individual.  
 Fig. 2. *Leperditia Okeni*, var. *inornata* (M' Coy): left valve.  
 Fig. 3. *Leperditia Okeni*, var. *obliqua*, nov.: left valve.  
 Fig. 4. *Bairdia æqualis*, D'Eichw.: a, right side; b, dorsal; c, ventral edge; d, end view.  
 Fig. 5. *Bairdia ampla*, Reuss: a, right side; b, ventral edge; c, end view.  
 Fig. 6. *Bairdia plebeia*, Reuss, var. *rhombica*, Jones: left valve.  
 Fig. 7. *Bairdia plebeia*, var. *munda*, nov.: left valve.  
 Figs. 8 a, b, c, 9 a, b, 10 a, b, c. *Cythere* (*Potamocypris*?) *bilobata* (Von Münster). Three individuals in various aspects.  
 Fig. 11. *Beyrichia intermedia*, Jones & Holl: left valve.  
 Fig. 12. *Primitia Eichwaldi*, sp. nov.: a, left valve, with wrinkled ornament; b, ornament, from a reticulated portion, magnified 84 diameters.  
 Fig. 13. *Cytherella Murchisoniana*, sp. nov.: a, left valve; b, edge view.  
 Fig. 14. *Cytherella Murchisoniana* (cast): a, right valve; b, edge view; c, end view.

\* Under the heading "*Bairdia curta*" in 'Lethæa Rossica,' loc. cit., M. d'Eichwald gives Tschernischine, Goroditz, Borowitschi, and Sloboda as localities for at least three varieties, and he quotes it also from the 'Old Red Sandstone with Fucoids.'

IX.—Notes on Coleoptera, with Descriptions of new Genera and Species.—Part III. By FRANCIS P. PASCOE, F.L.S. &c.

[Plate VIII.]

List of Genera and Species.

PRIONIDÆ.	MONOCHAMINÆ.
PRIONINÆ.	Monochamus fulvicornis.
Miocydus ( <i>n. g.</i> ) prionoides.	— acanthias.
CLOSTERINÆ.	CEROPLÉSINÆ.
Elaptus brevicornis.	Eunithera ( <i>n. g.</i> for <i>Thysia</i> viduata).
COLPODERINÆ.	Ceroplesis sumptuosa.
Eudianodes Swanzyi.	— aulica.
CERAMBYCIDÆ.	PHRYNETINÆ.
CEMINÆ ?	Psycholupis ( <i>n. g.</i> ) Fahræi.
Ectinope ( <i>n. g.</i> ) spinicollis.	HEBESÉCINÆ.
PHORACANTHINÆ.	Hebesecis anisocera.
Tryphocharia Mastersii.	— cristata.
STRONGYLURINÆ.	PROTORHOPALINÆ.
Lygesis mendica.	Protorhopala elegans.
URACANTHINÆ.	NIPHONINÆ.
Uracanthus strigosus.	Praonetha Dohrnii.
Emenica ( <i>n. g.</i> ) nigripennis.	Chætostigme ( <i>n. g.</i> ) casta.
PYTHEINÆ ?	Corrhenes grisella.
Titurius ( <i>n. g.</i> ) calcaratus.	— fulva.
LAMIIDÆ.	— cruciata.
DORCADIONINÆ.	Symphyletes torquatus.
Corestetha ( <i>n. g.</i> ) insularis.	Achriotypa ( <i>n. g.</i> ) basalis.
	Rhytiphora latifasciata.
	Penthea melanosticta.
	PERICOPTINÆ.
	Bebelis picta.
	— acuta.

MIOCYDUS.

(Prioninæ.)

*Priono affinis*, sed *clypeo* fronte continuato, *labro* invisio, *antennis* serratis, et *tarsis* brevioribus.

The lip, except a few stiff hairs fringing its anterior margin, is quite hidden by the clypeus, which is not marked off from the front by any line or impression as in *Prionus*. The antennæ have all the joints from the fifth to the tenth inclusive dilated on one side towards the apex. My specimen appears to be a male.

*Miocydus prionoides*. Pl. VIII. fig. 9.

*M. nitide* castaneus, subtus rufo-brunneus, supra irregulariter sat dense punctatus; vertice capitis longitudinaliter canaliculato; prothorace latitudine duplo longiore, utrinque bispinoso, angulis anticis rotundato, basi apiceque evidenter marginato; scutello sat brevi, subscutiformi; elytris lateraliter gradatim angustioribus, tenuiter elevato-lineatis, apice late rotundatis; antennis pedibusque rufo-brunneis, illis corpore brevioribus; sternis fulvo-hirsutis. Long. 9 lin.

*Hab.* West Australia.

*Elaptus brevicornis*. Pl. VIII. fig. 8.

*E. fuscus*, vel rufo-castaneus, omnino tenuiter pubescens; antennis ( $\sigma$ ) dimidium elytrorum paulo superantibus, ( $\varphi$ ) multo brevioribus; oculis infra haud approximatis; prothorace tenuiter punctato; scutello apice late rotundato; elytris sat vage punctatis, singulis lineis tribus modice elevatis munitis; corpore infra pedibusque pilis fulvescentibus longiusculis vestitis. Long. ( $\sigma$ ) 8, ( $\varphi$ ) 9 lin.

*Hab.* South Australia (Gawler).

This species differs from *E. simulator* in the smaller eyes, less approximate beneath, in the shorter antennæ, which in the male of that species extend to the end of the elytra, and in the much broader prothorax.

*Eudianodes Swanzyi*. Pl. VIII. fig. 7.

This species was shortly described by me in the 'Proceedings of the Entomological Society,' 1868, p. xiv. It is about 11 lines long, glossy black, inclining to a very deep chestnut-brown, with a fulvous trilobed patch on the prothorax. It differs generically from *Colpoderus*, *inter alia*, in its broader flat mesosternum and simple tibiæ; that is to say, they are not carinated along the external edge, nor is the external apical angle bidentate as in *Colpoderus*. I owe my specimen (the only one I have seen, and apparently a female) to Mr. Swanzy, whose collector took it at Cape-Coast Castle.

## ECTINOPE.

(*Eminæ*?)

*Caput* breve, inter antennas excavatum; *clypeus* latus, apice truncatus; *labrum* transversum. *Oculi* laterales, suboblongi, medio-criter emarginati. *Palpi* maxillares longiores. *Antennæ* setaceæ, corpore vix longiores: articulo basali brevi, subcylindrico, tertio longiusculo, cæteris brevibus, subæqualibus. *Prothorax* elongatus,

supra inæquatus. *Scutellum* scutiforme. *Elytra* angusta, prothorace paulo latiora. *Pedes* mediocres; *femora* incrassata, intermedia et postica subpedunculata; *tibiae* apice calcaratae; *tarsi* breves. *Coxae* anticae et intermediae subglobosae, haud contiguae. *Mesosternum* horizontale. *Abdomen* corneum, segmentis longitudine fere aequalibus.

Mr. Masters has sent me a single specimen of this new form, apparently a male. So far as I have been able to examine it without dissection it appears to me to belong to the *Cēminæ*, a subfamily whose genera are mostly highly specialized. I can say nothing of its affinities, except that its eyes are like those of *Ciopera*, and that in habit it resembles *Neocorus ibidionoides*. Its anterior cotyloid cavities appear to be open behind; but of this I am not quite sure: a remarkable peculiarity is the erect spine on each side of the prothorax at the base, (owing to its direction) not noticeable in the figure.

*Ectinope spinicollis*. Pl. VIII. fig. 3.

*E.* anguste elongata, fulvo-testacea, sparse pilosa; capite prothoraceque creberrime punctulatis, hoc latitudine fere duplo longiore, postice paulo angustiore, dorso tuberculis quinque, scil. duobus pone medium sitis, duobus præbasalibus, altero intermedio, basi utrinque spina valida erecta armato; elytris paulo depressis, confertim punctatis, spatiis inter puncta subgranuliformibus, apicibus rotundatis; corpore infra subnitido. Long. 4 lin.

*Hab.* Sydney.

*Tryphocharia Mastersii*.

*T.* depressa, rufo-brunnescens, pone basin elytrorum subfasciatim fulvescens, vage pilosa; capite sat rude crebre, occipite subcorrugato-punctato; antennis (♀) corpore manifeste brevioribus; prothorace minus depresso, subtransverso, supra leviter vel fere obsolete punctato, tuberculis quinque indeterminatis instructo, lateraliter leviter tuberculato; scutello subtriangulari; elytris subnitidis, sat crebre punctatis, punctis ad apicem gradatim fere evanescentibus, apice singulorum breviter bispinoso; corpore infra pedibusque sat sparse griseo pilosis; femoribus in medio parum incrassatis. Long. 19 lin.

*Hab.* Victoria (Melbourne).

The genus *Tryphocharia* was not adopted by Lacordaire, who, as he afterwards wrote me, was completely mistaken in his identification of the species on which it was founded\*,

\* In another case I noticed that in his collection at Liège the genus *Allotisis* was represented by a small specimen of *Phoracantha senio*; there were two or three other Longicorns (and there might have been more) which were also wrongly named.

and whose intention it was to publish omissions and corrections in a Supplement\*. This fine species finds its nearest ally in *T. Odewahnii*, from which it differs in its bispinous and less closely punctured elytra, the slightly thickened femora, the tubercle (not spine) at the sides of the prothorax, &c. Judging from *T. Odewahnii*, there is not much difference in the length of the antennæ in the two sexes.

*Lygesis mendica.*

*L.* nitide castanea, postice pallidior, sparse griseo-pilosa; capite antice leviter producto; prothorace latitudine sesquilingiore, sat sparse irregulariter punctulato; scutello dense griseo-villoso; elytris longiusculis, basi sparse punctatis; femoribus modice clavatis. Long. 4-4½ lin.

*Hab.* New South Wales (Rope's Creek).

Closely allied to *L. cylindricollis*; but the elytra considerably longer, and the prothorax much less punctured; the punctures, however, are only to be seen in abraded examples.

*Uracanthus strigosus.*

*U.* silaceus, pilis fulvo-griseis vittatim vestitus; capite modice elongato; mandibulis apice nigris; palpis ferrugineis; prothorace latitudine paulo longiore, utrinque in medio fortiter calloso; elytris prothorace fere quinquies longioribus, apicibus introrsum emarginatis bispinosis, spina suturali et exteriori fortiter productis; corpore infra pedibusque sat dense adperso-villosis. Long. 9 lin.

*Hab.* New South Wales (Rope's Creek).

This species is readily distinguished by its fulvous-grey hairy stripes, the intervals naked; the prothorax is shorter than in the other species, and with a larger lateral callus.

EMENICA.

(Uracanthinae.)

*Caput* antice elongato-quadratum, inter antennis sulcatum; *clypeus* magnus; *labrum* breve. *Oculi* medioeres, leviter emarginati. *Antennae* lineares, subvalidae, corpore longiores, articulo basali breviusculo, tertio longitudine fere aequali, cæteris longioribus, apice (ultimo excepto) obliquis. *Prothorax* oblongus, subcylindricus. *Scutellum* triangulare. *Elytra* elongata, basi prothorace vix latiora, lateribus subparallelis, apicibus rotundatis. *Pedes*

\* In the 'Genera' (ix. p. 411, note) we are told that we should find this Supplement at the end of the volume; but at his lamented death it could not have been in a state for publication.



breves; *femora* modice incrassata; *tarsi* lineares. *Coxæ* anticae subglobosæ, haud contiguæ. *Mesosternum* horizontale. *Abdomen* elytra superans.

Lacordaire places Uracanthinae in one and Stenoderinae in the other of the two "sections" into which he divides his "Cerambycides vrais Sylvains," the former having coarsely, the latter (with certain exceptions) finely faceted eyes; *Emenica*, therefore, will go with the former.

*Emenica nigripennis*. Pl. VIII. fig. 2.

*E.* brunneo-rufa, pedibus infuscatis, elytris (basi exceptis) nigris; capite confertim punctato; antennis fuscis, articulis tribus basalibus nitidis, cæteris tomentosis; prothorace confertim rude punctato, in medio linea longitudinali impresso; elytris crebre punctatis, singulis lineis duabus parum elevatis munitis; corpore infra fulvo-testaceo; metasterno infuscato. Long. 6 lin.

*Hab.* West Australia.

TITURIUS.

(Pytheinæ?)

*Caput* subverticale, productum; frons lata, planiuscula. *Oculi* profunde emarginati. *Pulpi* maxillares articulo ultimo fusiformi, apice obtuso. *Antennæ* corpore breviores, 11-articulatæ, extorsum crassiores; articulo basali obconico, tertio quartoque æqualibus. *Prothorax* vix transversus, utrinque callosus, supra æquatus. *Elytra* subdepressa, elongata, parallela, prothorace paulo latiora. *Pedes* breves; *femora* parum incrassata; *tibiæ* teretes; *tarsi* subangusti, articulo ultimo elongato, unguiculis divaricatis. *Coxæ* anticae globosæ, sejunctæ, vix exsertæ. *Pectus* ante coxas transverse constricto-sulcatum. *Corpus* angustum, pilis volatilibus munitum.

I have only a single specimen of this interesting Longicorn, which I refer, although with some hesitation, to the Pytheinæ. I adopt the term "pili volatiles" after Schiödt for the long, slender, erect hairs sometimes found clothing the body, and often also the legs. The Danish author is of opinion that they facilitate flight by giving a greater circumference without increasing weight in the same degree. Would they not rather have a contrary effect? The spur on the hind tibiæ is possibly a sexual character.

*Titurius calcaratus*.

*T.* elongatus, capite antennisque chalybeatis, illo rude crebre punctato; prothorace æneo-micante, rude punctato; scutello nigro, transverso, apice rotundato; elytris chalybeatis, basi rufis, irregulariter rude punctatis; corpore infra nitide æneo, vage punctulato;

femoribus rufis; tibiis tarsisque subchalybeatis; tibiis posticis apice supra spinoso-productis. Long.  $3\frac{1}{2}$  lin.

*Hab.* New South Wales (Rope's Creek).

#### CORESTETHA.

(Dorcadioninæ.)

*Caput* parvum, inter antennis latum, fronte transversa; *labrum* amplum, antice rotundatum. *Oculi* late emarginati, fortiter granulati. *Antennæ* corpore vix longiores, articulo basali subpyriformi, tertio longiusculo, recto, cæteris gradatim brevioribus. *Prothorax* oblongus, cylindricus, capite haud latior. *Scutellum* nullum. *Elytra* oblonga, prothorace haud latiora. *Pedes* breves; *femora* valida; *tibiæ* omnes breves, intermediae profunde emarginatae, posteriores haud compressæ. *Coxæ* anticae globosæ, sejunctæ. *Pro-* et *mesosterna* elongata. *Abdomen* segmento basali duobus sequentibus conjunctim longiore.

Closely allied to *Mesolita*; but while the posterior tibiæ are scarcely as long as the tarsus, and terete, in *Mesolita* they are twice as long and compressed. The eyes have fewer facets than in any other species I have examined: in *Mesolita transversa* they are rather finely, while in *M. lineolata* they are somewhat coarsely faceted. This is therefore one of those genera in which the facets of the eyes have only a specific value. The species described below varies in the testaceous becoming more or less of a smoky brown, like the general colour.

#### *Corestetha insularis.*

*C. angusta*, infuscata, subtiliter pubescens, supra confertim tenuiter punctulata; capite antice transverso; antennis testaceis, nigro annulatis, articulo basali oblongo-pyriformi; prothorace latitudine sesquilingiore; elytris fere obsolete striatis, fasciis duabus subtestaceis, aliquando ad suturam interruptis, una basali, altera pone medium, obsitis; pedibus subtestaceis, vel infuscatis. Long.  $1\frac{1}{2}$ -2 lin.

*Hab.* Eclipse Island.

#### *Monochamus fulvicornis.*

*M. angustus*, fuscus; antennis ( $\sigma$ ) corpore plus duplo longioribus, clare fulvis, articulo basali excepto; capite griseo-pubescente, impunctato, in medio longitudinaliter sulcato; tuberculis antenniferis validis; prothorace transverso, in medio leviter punctulato, spina laterali minus robusto; elytris modice elongatis, postice angustioribus, apicibus rotundatis, supra fere æquatis, modice punctulatis; corpore infra pedibusque breviter griseo tomentosis; tibiis anticis haud elongatis, flexuosis. Long. 8 lin.

*Hab.* Japan (Nagasaki).

This species was taken many years ago by Mr. Whitely, and was unknown to Mr. Lewis, who has formed extensive collections in Japan. I think it may be placed after *M. varioraris*.

*Monochamus acanthias*.

*M. robustus*, pube sericante griseo-fulvescente tectus; capite antice punctis perpaucis impresso; antennis (♂) corpore plus duplo longioribus, 12-articulatis, pallidis, nigro-annulatis; prothorace valde transverso, sparse punctulato; elytris ampliatis, postice angustioribus, apicibus angulo exteriore spina elongata armatis, supra inæquatis, oblique biplagiatis saturatoribus, irregulariter sparse punctatis; corpore subtus pedibusque dense flavidulo-pubescentibus; tibiis anticis vix elongatis, flexuosis. Long. 12 lin.

*Hab.* New South Wales (Manning River).

The nearest allies of this species appear to be *M. argutus* and *M. solatus*; the latter, which has a dull mottled greyish pubescence, has I believe been also taken at Cape York. The other Australian species have the apices of the elytra rounded. In this species the spine is comparatively unusually long and slender, and is directed towards the median line of the body. The tendency of the antennæ to form a twelfth joint by the division of the eleventh is shown in many species by a dark ring, at about two thirds of the length of the latter, simulating a joint; in this case, though it may not be invariable, the separation is well marked. I have adhered to the original generic name as it was used by Latreille, Serville, and others. *Monohammus* (from *μόνος* and *ἄμμα*) has no application, and is only misleading; and if such be its derivation, I take it that the orthography should be *Monammus*.

EUNITHERA.

(Ceroplesinæ.)

A *Thysia* differt articulo basali antennarum cicatricoso, unguiculis divergentibus; mesosternum elevatum, antice productum.

The type *Thysia viduata* \* (Pl. VIII. fig. 4) is apparently so closely allied to *Thysia* that, notwithstanding its differently formed mesosternum, I had no hesitation in placing it in that genus. Since, however, the appearance of Lacordaire's ninth volume I have reexamined it, and find that two important characters in the classification of that author, viz. the relative position of the claws to one another and the cicatrix of the basal joint of the antennæ, would not strictly permit it to

\* *Antè*, Annals, ser. 4, vol. iv. p. 208.

remain even in the same subfamily. There are, however, in my opinion cases, as in this, in which a character becomes almost purely arbitrary: in the species before us the exceptional characters are sufficiently recognized by generic distinction\*.

*Ceroplesis sumptuosa.*

*C. oblonga*, nigra, supra pube tenuissima alba parce adspersa, infra nitida, pilis brevibus volitantibus induta; capite inter oculos profunde sulcato, tuberibus antenniferis alte elevatis; antennis ( $\sigma$ ) corpore sesquolongioribus, ( $\varphi$ ) parum longioribus; prothorace transverse tumido, utrinque in mare subbituberculato, punctis paucis irregulariter adperso, tomento brunneo-miniato dense tecto; scutello valde transverso, postice rotundato; elytris prothorace plus triplo longioribus, bronzino-nigris, basi rugoso-punctatis, postice punctis sensim minoribus et minus confertis, fasciis duabus determinatis integris invicem atque a basi æqualiter distantibus, margineque apicali roseo-miniatis ornatis; tibiis anticis ( $\sigma$ ) longiuseulis, apice parum arcuatis. Long. 14–15 lin.

*Hab.* Cape (Grahamstown).

From *C. tricincta*, Ol., the nearest ally, this handsome species differs in the diverging antennary tubers, the transverse bulging of the middle of the prothorax, which is covered with a dense maroon or claret-coloured tomentum, the glossy bronze (almost golden) hue of the elytra, except the pinkish or dark rosy bands, and the anterior tibiæ of the males longer and less curved. *C. marginalis*, Fähr., seems to me scarcely distinguishable from *C. ferrugator*, Fab. I have recently received *C. bicincta* from Angola, hitherto only recorded from the Cape.

*Ceroplesis aulica.*

*C. nigra*, subtus prothoraceque sparse griseo-pubescentibus; capite pilis griseis sparsis induto, tuberibus antenniferis divergentibus,

\* The Munich Catalogue erroneously makes *Thysia tricincta*, Cast., synonymous with *T. Wallichii*, Hope. The errors in this most useful and extensive work (it already reaches to 3478 pages) seem to be fewer than could reasonably have been anticipated; but the authors in some cases seem to have wilfully gone out of their way to create mistakes, as, for instance, in referring *Pascoëa Idæ* to *Tmesisternus mirabilis*, *Anthores leucnota* to *Monohammus asperula*, &c. The great defect of the work is the restoration of names that have been dropped in consequence of their being preoccupied elsewhere. Dr. Gemminger and the Baron de Harold have adopted a very narrow rule. So long as names have not been used for a Coleopterous genus, it matters not that they have been used in other orders of insects; but on this principle, carrying it a step further, the specialist in Carabidæ, for example, would be justified in taking the names of any other family of Coleoptera, and the same generic name might be used in every family of the animal kingdom.

haud productis; prothorace modice transverso, utrinque tuberculo fere obsoleto, pone medium munito; elytris cylindricis, fasciis tribus æqualibus nigris, quarum una basali, una media, una præ-apicali, apice ipso fasciisque duabus intermediis læte fulvidis ornatis; pedibus pilis brevibus adpersis. Long. 8 lin.

*Hab.* Angola.

A comparatively small and somewhat aberrant species; it stands in Dejean's Catalogue under the name here adopted.

### PSYCHOLUPIS.

(Phrynetinæ.)

*Frons* convexa; vertex elevatus, supra antennis excavatus; *clypeus* brevissimus, valde transversus, a fronte sulco recto discretus. *Oculi* maximi, lobo inferiore quadrato, ad oram approximati. *Antennæ* lineares, breves, articulo basali longiusculo, tertio usque ad quintum gradatim brevioribus, cæteris brevibus cylindricis. *Prothorax* transversus, apice basique æqualis, utrinque spina valida armatus. *Elytra* oblonga, subparallela, modice convexa, basi bisinuata, humeris paulo porrectis. *Pedes* validi, antici breviores; *femora* brevia; *tibiæ* breviter calcaratæ; *unguiculi* divergentes. *Prosternum* postice in dente acuto productum; *mesosternum* apice callosum.

The only species of this genus, although well known, does not appear to have been described; but I believe it is somewhere mentioned by M. Reiche under the above name. From *Pachystola* and other genera it is known by its short, linear, not setaceous antennæ, and from the former also by entire intermediate tibiæ. What I take to be the male has somewhat longer antennæ. I have named the only known species after the learned Swede Ol. Im. Fähræus.

#### *Psycholupis Fahræi.*

*P. elongatus*, fuscus, omnino dense griseo-pubescent, fere obsolete silaceo-maculatus; capite sat magno, inter antennis leviter excavato, antennis ♀ corporis dimidio paulo longioribus; prothorace antice transversim flexuoso-sulcato, in medio paulo depresso, tuberculis tribus planatis munito; scutello subtransverso; elytris elongatis, parallelis, dimidio basali, regione suturali excepta, sat confertim fortiter punctatis, apicibus sutura leviter productis; abdomine marginibus segmentorum nitide nigris. Long. 15 lin.

*Hab.* Angola.

#### *Hebesecis anisocera.*

*H. robusta*, nitide nigra, pube fulvo-grisea sat sparse tecta; capite confertim punctulato, antice oblongo, linea elevata utrinque

munito: antennis ( $\sigma$ ) corpore duplo vel fere triplo longioribus, 12-articulatis, articulis sexto et octavo cinereis; prothorace sat valde transverso, crebre punctulato, spina valida pone medium utrinque armato: elytris sat grosse et modice confertim punctatis, fasciis duabus arcuatis notatis, una ante altera pone medium obsitis; corpore infra interrupte griseo-pubescente; pedibus parce pilosis, subtiliter pubescentibus. Long.  $5-7\frac{1}{2}$  lin.

*Hab.* Queensland.

The 12-jointed antennæ of the male is a character occurring also in the following species; and I find it as well in *H. basalis*. It may be noticed that the apical portion is thickened in some individuals, owing to the penultimate joint being of the same size as the one preceding, and both, as well as the last, being closely fringed. In general appearance this species might be taken at the first glance for *H. australis*; but the transverse face of the latter, without the raised lines at the sides, will readily differentiate it.

*Hebesecis cristata.*

*H.* nitide nigra, pube inæquali fulvo-grisea sat sparse tecta; capite rugoso-punctato, antice transverso, linea elevata utrinque munito, tubericibus antenniferis remotis; antennis ( $\sigma$ ) corpore plus duplo longioribus, 12-articulatis, articulis sexto, octavo, nono basi, et tribus ultimis cinereis; prothorace modice transverso, suberebre punctulato, dorso utrinque calloso, lateraliter fortiter conico-spinoso; elytris subtrigonatis, sat sparse punctatis, costulis magis elevatis, basi singulorum piloso-eristatis, pone medium fascia nigra notatis; corpore infra abdomineque lateraliter albedo-pilosis; pedibus parce pilosis, subtiliter pubescentibus. Long.  $4\frac{1}{2}-5\frac{1}{2}$  lin.

*Hab.* Queensland (Gayndah).

There is a dark stripe bordered with white externally on each side of the prothorax of one of my specimens; the clytral crest is also black, and the pubescence of a whitish grey; the amount of ashy colour on the antennæ is also variable. This species is allied to *H. basalis*; the latter, *inter alia*, has the antennary tubers more produced and approximate, and the terminal joints of the antennæ nearly as short again.

*Protorhopala elegans.* Pl. VIII. fig. 1.

*P.* testaceo-rufa, pube alba tenuiter sat dense vestita, maculis clytrorum exceptis; antennis attenuatis, corpore longioribus, articulis tertio quartoque æqualibus longiuseculis, hoc subarcuato; prothorace transverso, utrinque in medio tuberculo parvo munito; scutello transverso, apice rotundato, dense albo-tomentoso; elytris basi rude punctatis, singulis maculis tribus denudatis nitidis irregularibus munitis, scil. una basali, una media majore, una versus

apicem sita; corpore infra pedibusque minus pubescentibus. Long. 8 lin.

*Hab.* Madagascar.

This is a very distinct species, and may be hereafter considered to be generically distinct from *P. sex-notata*.

*Praonetha Dohrnii.*

*P. breviuscula*, picco-fusca, umbrino, postice variegatim albido pubescens; antennis subannulatis, articulo tertio quam primo vix longiore; prothorace subtransverso, vage punctato, in medio bicalloso; scutello transverso; elytris sat brevibus, utrinque gradatim angustatis, apicibus rotundatis, vage punctatis, versus apicem subsulcatis, basi et pone medium (fere obsolete) nigro-cristatis, illa fasciolata; abdomine leviter maculato. Long. 4 lin.

*Hab.* Ceylon.

This little species belongs to my fourth section of the genus (Longic. Malayana, p. 174), characterized by the basal crests and by the gradually declivous posterior portion of the elytra; but it differs from every other species of the section in the presence of two well-marked tubercles on the prothorax. In so large a genus, where the coloration is confined to various shades of brown with obscure or indefinite spots or markings of greyish or whitish (and even in individuals of the same species there is sometimes a considerable modification caused by the predominance of one or the other of these colours), it becomes very difficult to give an accurate idea of the characters in these respects: in the specimen before me there are two or three concentric black and white lines on the posterior half of the elytra, the innermost black line at its commencement anteriorly marking the position of the postmedian crest (or tubercle). I owe my examples to the well-known polyglot president of the Entomological Society of Stettin, after whom I have named it\*.

CHÆTOSTIGME.

(Niphoninæ.)

*Caput* in medio longitudinaliter sulcatum; *frons* convexa. *Oculi* profunde emarginati. *Antennæ* setaceæ, corpore longiores, pilis volitantibus adspersæ, articulo basali longiusculo, tertio quartoque longioribus, æqualibus, hoc arcuato, cæteris dimidio brevioribus. *Prothorax* latitudini longitudine æqualis, lateribus inermis, basi

\* Dr. Gerstäcker ('Die Gliederthier-Fauna des Sansibar-Gebietes,' p. 261) enumerates *P. melanura*, a Malayan species, among the insects of Zanzibar. His *Phoryctes mucoreus* is evidently *Enaretta Castelnaudi*, Thoms.; and his *Rhopalizus sansabarius* is a *Callichroma*.

bisinuatus. *Elytra* prothorace duplo longiora, basi latiora, postice gradatim angustiora, humeris rotundata. *Pedes* mediocres, fere aequales. *Pro-* et *mesosterna* inter coxas elevata, haud producta.

This genus may be placed near *Micracantha*, Montr.; but, *inter alia*, it wants the prothoracic tubercle, and the antennæ have a longer basal joint. The outline of the prothorax and elytra is different; and hence the affinity of the two genera is not at once obvious. The species described below is covered with a whitish pubescence, the elytra having scattered bristle-like hairs, each arising from an areolated puncture. The antennæ, owing to the disposition of the pubescence, have an annulated appearance.

*Chatostigme casta*. Pl. VIII. fig. 5.

*C. fusca*, pube griseo-alba dense tecta; antennis apice articulorum excepto sparse pubescentibus; prothorace antice paulo angustiore, utrinque modice rotundato; scutello transverso, postice rotundato; elytris disperse punctatis, punctis fusco-marginatis, singulis in medio pilum longiusculum emittentibus; corpore infra pedibusque minus dense vestitis. Long. 4 lin.

*Hab.* West Australia (Nicol Bay).

*Corrhenes grisella*.

*C. fulvo-ferruginea*, sat rude griseo-pubescentibus, pilis erectis albidis adpersa; antennis nigris, basi articulorum, ultimo excepto, albidis, articulo primo quam tertio brevioribus; prothorace cylindrico, latitudine vix longiore; elytris angustioribus, parallelis, maculis nudis minutis adpersis; corpore infra pedibusque albido-pubescentibus; abdomine segmento primo fulvo-marginato. Long. 3½ lin.

*Hab.* Australia (Nicol Bay).

Much narrower than *C. paulla*, of a more uniform colour, the antennæ with a shorter basal joint, and the elytra finely speckled.

*Corrhenes fulva*.

*C. valida*, ferruginea, omnino dense fulvo-pubescentibus, supra pedibusque pilis erectis nigris numerosis adpersa; capite antice valde transverso, vertice elevato; oculis parvis, antice remotis; antennis crassiusculis, fuscis, articulo primo quam tertio evidenter brevioribus; prothorace modice transverso, versus apicem leviter constricto; elytris subtiliter punctatis, maculis saturatioribus adpersis. Long. 5-6 lin.

*Hab.* Australia (Rockhampton).

A stouter species than *C. paulla*, with a proportionally larger head, more transverse anteriorly &c.



*Corrhenes cruciata.*

*C. valida*, ferruginea, supra pube griseo-fusca dense tecta, pilis minus numerosis subadpressis adpersa; capite antice transverso; oculis mediocribus; antennis ♂ corpore paulo longioribus; prothorace subtransverso, cylindrico, disco vittis duabus indeterminatis munito; elytris basi paulo latioribus, humeris prominulis, apicibus oblique truncatis, lineis duabus albis vel fulvis a basi usque ad tertiam partem, figura X-formi, ornatis; corpore infra pedibusque minus dense pubescentibus. Long. 6–10 lin.

*Hab.* Queensland.

A very distinct species, originally found by Mr. Masters at Gayndah.

*Symphyletes torquatus.*

*S. fuscus*, pube plerumque fulvo-grisea dense tectus, supra maculis fulvis minutis adpersus; capite infra et pone oculos fulvo-pubescente; antennis (♂) corpore sesquilongioribus, infra leviter ciliatis; prothorace latitudine vix longiore, tuberculis laterali-bus distinctis; scutello subscutiformi; elytris sparse granulatis, postice gradatim angustatis, plaga fusca arcuata, in medio fulvo-notata, parte quarta basali ornatis, singulis basi tuberculis spini-formibus circa octo in seriebus duabus—interiore quinque, exteriori tribus—instructis, apice truncatis; corpore infra pedibusque griseo-pubescentibus, segmentis abdominis pilis fulvis fimbriatis. Long. 9–10 lin.

*Hab.* Queensland (Gayndah).

In the male the anterior coxæ are armed with a curved spine, as in many other species of this large genus; the female is stouter, and the antennæ are not quite so long. This very distinct species may be placed after *S. cinnamomeus*.

## ACHRIOTYPA.

## (Niphoninæ.)

*Caput* mediocre, inter antennas latum, excavatum. *Oculi* subdivisi, grosse granulati, lobo inferiore rotundato. *Antennæ* setaceæ, articulis quatuor ultimis æqualibus. *Prothorax* cylindricus, lateraliter inermis. *Elytra* parallela, prothorace paulo latiora. *Pedes* perbreves; *tarsi* articulo ultimo valido. *Pro-* et *mesosterna* simplicia.

An elongate, cylindrical form, with unusually short legs, and slender setaceous antennæ with the last joint not hooked or curved at the tip. The pro- and mesosterna are as in *Symphyletes*, to which genus it may for the present be approximated, in habit approaching such species as *S. variolosus* and its allies.

*Achriotypa basalis.*

*A. elongata*, subcylindrica, fusca, pube grisea sparse tecta; elytris sat disperse punctatis, margine exteriore in medio niveis, basi macula nigra notatis, apicibus late emarginatis; antennis articulis tertio quartoque, hoc apice excepto, niveis; prothorace dense punctulato, margine basali nigro-binotato; corpore infra castaneo, parce pubescente. Long.  $4\frac{1}{2}$  lin.

*Hab.* New South Wales (Rope's Creek).

*Rhytiphora latifasciata.*

*R.* omnino nitide nigra, pube silacea interrupta vestita; capite antice valde transverso, fronte lata, tuberibus antenniferis remotis, vertice elevato, in medio postice sulcato, pube lineatim notato; prothorace transverso subcylindrico, utrinque tuberculo parvo instructo, supra pube vermiculatim disposita; scutello semicirculari; elytris paulo depressis, singulis lineis tribus obsoletis notatis, fascia lata fulvo-albida submedia, antice arcuata, postice flexuosa, ornatis, apicibus subtruncatis; metasterno ad latera tumido; tibiis brevibus. Long. 11 lin.

*Hab.* Australia (Cape York).

An aberrant species, having a certain resemblance to *Euclea capito*.

*Penthea melanosticta.*

*P.* omnino dense albido-pubescentis, nigro-maculata; capite antice transverso, tuberibus antenniferis remotis; antennis (♀) corpore brevioribus, nigris, basi subalbidis; prothorace subtransverso, cylindrico, utrinque dente parvo instructo; scutello semilunari; elytris basi paulo latioribus, dorso utrinque dimidio anteriore leviter lineatim elevato, apicibus subemarginatis; pedibus vix maculatis. Long. 6 lin.

*Hab.* West Australia (Nicol Bay).

This species is allied to *P. miliaria*, which, with *scenica*, *picta*, *sectator*, and *crassicollis*, seem to constitute a group somewhat different from the ordinary *Penthee*. Lacordaire (Gen. x. p. 560) says the genus is easily known by two tomentose depressions of the abdomen in both sexes; and in a note he adds, "No author that I know of has mentioned this character." I had, however, previously called attention to it in a species of a closely allied genus, *Symphyletes pubiventris* (Journ. of Entom. i. p. 339), but in which the two patches were so close together as to cover nearly the whole of the segment. Subsequently I found that this character might or might not exist in the same species, or in either sex; and it seemed to me so unsatisfactory, that, as a rule, I have ceased to mention it.

*Bebelis picta.*

*B. breviusecula*, fusca, griseo-pubescens; antennis crassiusculis, linearibus, longitudine corporis; prothorace subcylindrico, vittis indeterminatis sex, quatuor nigris, duabus lateralibus albis, ornato; scutello albo-griseo; elytris brevibus, apicibus subtruncatis, lineis obliquis curvatis basalibus, maculis lateralibus, aliisque apicalibus, albis, nigro-marginatis, ornatis; corpore infra pedibusque brunneis, sparse griseo-pubescentibus. Long.  $3\frac{1}{4}$  lin.

*Hab.* Rio Janeiro.

Considerably shorter than *B. lignosa*, Thoms., and with stouter antennæ; the stripes at the base, black, white, grey, with white and black again, are curved, and with their fellows enclose a heart-shaped space in the region of the scutellum; the lateral and apical spots have a similar coloration, but much less distinct.

*Bebelis acuta.* Pl. VIII. fig. 6.

*B. elongata*, fusca, griseo-pubescens; antennis setaceis, corpore brevioribus; oculis parvis; prothorace subcylindrico, macula  $\Lambda$ -formi, externe albo-marginata, basin versus notato; scutello albo-griseo; elytris postice sensim angustioribus, apice extus in spinam dentiformem productis, et ut in præcedente fere ornatis, sed lineis basalibus minus obliquis. Long.  $4\frac{1}{2}$  lin.

*Hab.* Rio Janeiro.

In the figure the elytra are represented too much rounded at the sides, and they are not sufficiently elongate. In this genus the eyes are coarsely granulate; and in the former as well as in the typical species they fairly answer M. Thomson's designation "submagni;" but in this species they are decidedly small, and the connexion of the upper lobe to the lower is indicated only by a very long narrow line. I owe all my specimens to Mr. Fry.

## EXPLANATION OF PLATE VIII.

- Fig. 1. *Protorhopala elegans.*  
 Fig. 2. *Emerica nigripennis.*  
 Fig. 3. *Ectinope spinicollis.*  
 Fig. 4. *Eunithera viduata.*  
 Fig. 5. *Chætostigme casta.*  
 Fig. 6. *Bebelis acuta.*  
 Fig. 7. *Eudianodes Swanzyi.*  
 Fig. 8. *Elaptus brevicornis.*  
 Fig. 9. *Miocydus prionoides.*  
 Fig. 10. Hind leg of *Titurius calcaratus.*

X.—On the Genus *Bathyporeia*.

By the Rev. THOMAS R. R. STEBBING, M.A.

[Plato III.]

To Lindström's original species, *Bathyporeia pilosa*, two other species, *Robertsoni* and *pelagica*, have been added by Mr. Spence Bate. Of the last, however, he had seen but a single imperfect specimen, and none but dead imperfect specimens of the other two. As I have been more fortunate, and have been able to examine perfect and living specimens of these beautiful little creatures, I have no hesitation in reducing all three forms to a single species, the original *Bathyporeia pilosa*. There can scarcely be a doubt that what has been figured as *B. pilosa* is the female, that *B. pelagica* is its male, and that *B. Robertsoni* is also the male not yet arrived at maturity.

I have taken all three forms on, or rather in, the sands at Llanfairfechan. One specimen of the male I took at low tide near Bangor, one of the female at Pwllheli; so that the species is probably to be found all round the coast of North Wales. It burrows in the sand to the depth of half an inch or a little more, and exhibits very great activity in this proceeding. When in water it is equally vivacious, darting about in all directions.

The eyes are faceted, red, and in the mature animal large and kidney-shaped, but small and round in the young. The eyes increase by addition to the number of facets—a mode of growth well known in regard to these organs in the Amphipoda, and only requiring notice here because the eyes are given as round in the figure and description of *Bathyporeia Robertsoni*.

The upper antennæ do not supply, as was supposed, a mark of distinction between the form given as *B. pelagica* and the other two, since in all alike the secondary appendage to the flagellum has one large articulus followed by a very slender small one. They are also alike in other respects, and notably in the shape of the large first joint, which stands boldly out in a line with the head, but forms a considerable angle with the two following joints, very diminutive by comparison, and attached to an excavation some little way from its compressed distal extremity.

The lower antennæ do undoubtedly differ in the three forms; and it is upon these organs that most stress has been laid in distinguishing the supposed species. The principal difference, however, is in the length of the flagellum, which is very short

in the figure of *B. pilosa*, very long in that of *B. pelagica*, and of intermediate size in that of *B. Robertsoni*. But in the order Amphipoda, as with the facets of the eyes, so with the articuli of the lash of the antennæ, an increase takes place with advancing age. This part of the animal will not, therefore, of itself suffice for the establishment of a specific distinction. Still the figure with the lash of intermediate size has a character not attributed to either of the other forms. The distal end of each articulus of the flagellum is surmounted by an ornament in the shape of an elongated horse-shoe, to which Mr. Stimpson has given the name "*calceola*," informing Messrs. Bate and Westwood that it is a character of the male sex. In their description of *Lysianassa longicornis* these authors express the opinion that the "*calceolæ*" have the power of increasing the sense of smell to a more acute degree. In describing *Bathyporeia Robertsoni* they mention the additional circumstance that in the upper antennæ each articulus bears "a short auditory cilium of an oval form." Fritz Müller mentions, in his 'Facts for Darwin' (Translation by Dallas, p. 20), that he considers these "auditory cilia" of the upper antennæ to be olfactory organs, fortifying his opinion by the fact of their stronger development in the males than in the females of certain species, as in other cases male animals are not unfrequently guided by the scent in pursuit of the females. Whether *Bathyporeia* appreciates scent and sound by the lower and upper pairs of antennæ respectively or *vice versâ*, or whether to each or either of these purposes it applies both of them or neither, is a question for nice and careful experiment. This much, however, is certain, that the "*calceolæ*," whatever their use may be, were present in those specimens which had the antennæ about as long as the animal itself, thus bringing *B. pelagica* one step nearer to *B. Robertsoni*. Between the short flagellum and the long one the difference is considerable, the former having only some seven or eight articulations, while in the latter I counted thirty-two. It should also be stated that on none of the short flagella did I observe the slipper-shaped appendages, although the specimens of this form were considerably more numerous than those of the other two. On the other hand, I took the form that has short antennæ with the young upon it, establishing the point that this is a female form, though leaving it an open question whether its mate in all respects resembles it. The young just born had a strong family likeness to their mother. There did not seem to be any long antennæ among them; nor were they to be expected.

Of the other parts of the animal one description will equally

apply to males and females, adults and juveniles. The legs of the first pair were wanting in all Mr. Spence Bate's specimens. These are very small and delicate, and, both in living and dead specimens, are cuddled up within the coxae, as if they were too tender and precious for use. The wrist is long, and at its distal end as broad as the hand. The hand is nearly as broad as it is long, diminishing towards the finger, which is short and curved. The legs of the second pair are beautiful objects under a good lens or microscope. The wrist is larger than the hand, but of the same shape. Both are adorned with long plumose hairs; and the hand is fingerless. There is an awkwardness in speaking of hand and wrist as portions of a leg; but one is happy to escape when possible from the repetition of terms like the propodos of a gnathopodos or the ischium of a pereopodos, and there is a convenience in using accepted and easily intelligible terms which will atone for some linguistic improprieties. We proceed, then, to notice that the hands of the third and fourth pairs of legs are long and thin, and have fingers attached to them. These would appear to be very serviceable limbs, to judge by the activity of their movements, and also by the position to which they aspire; for they are constantly thrust forward in advance of the graceful but comparatively inactive second pair of legs; and this forward position they maintain with some obstinacy, even when the animal that owns them is dead.

The three following pairs of legs, like the second pair, are destitute of fingers. They are very actively employed in shovelling back the sand when the animal is burrowing into it. In the quiescent state, and after death, the lower joints of the fifth pair are cocked back, and the lower joints of the seventh pair are thrust forward, to such an extent that the three final couples seem almost to have their order of position exactly reversed. The fifth pair has the most curious appearance, because the hand and wrist are so slight and spindle-shanked compared with the well-developed joint to which they form an appendage. In this pair the wrist is longer than the hand. In the two following these proportions are reversed. Mr. Spence Bate assigns a long slender finger to the hand of the fifth pair in *B. pilosa*. As there is no finger at all to this pair in either of his other species, so unusual a difference between species of the same genus would be remarkable; but as my Welsh specimens have none of them any vestige of this finger, it must be concluded that in Mr. Bate's imperfect specimen the hairs at the extremity of the hand had assumed, as they well might do, the appearance of a finger. It may be remarked that the drawing of the finger in the 'British Ses-

sile-eyed Crustacea' might very well represent the coalescing of long hairs or setæ.

The fourth segment of the tail has a deep transverse sinus, generally very conspicuous, but sometimes, especially after the animal is dead, concealed by the hinder portion of the preceding segment. It is no doubt from this casual concealment that the want of a sinus has been attributed to *B. pelagica* as a specific difference. The form with the long antennæ certainly possesses the sinus in question in a manner perfectly well marked. The elevated part of the segment behind the sinus is surmounted by two short setæ and also by two short spines. The hairs stand upright; the spines generally point backwards. The segment is deeply excavated below as well as above.

There is a peculiarity worth noticing in the coxa of the first pair of legs. It does not lie parallel to those which follow it, but has a sort of neck at its upper part attached to the hinder part of the segment to which it belongs, the whole of this neck-like portion being completely covered by the coxa of the succeeding segment.

The skin of the animal is white and semitransparent. Some specimens have the tail part prettily blotched with pink. Under a high power, portions of the skin exhibit markings resembling those common on fish-scales.

Other species of this beautiful little genus will be welcome when they are forthcoming; but it has probably been made clear by the foregoing details that a single species of it must content us for the present. That the male should have more fully developed antennæ than the female is perhaps rather the rule than the exception among the Amphipoda. It is a little singular that in the same hunting-ground the full-grown male should have been much more rare than the other two forms, of the female and the young; but another afternoon's research might have altered the proportion of numbers altogether, while it would be extremely peculiar, not to say improbable, that the same stretch of sand should have yielded three different species of one genus, though yielding no other Amphipod, except the very different form of *Sulcator arenarius*.

Since writing the above account I have had the opportunity of searching the sands on the south coast, which stretch for about fourteen miles from Lancing by Worthing and Goring, and on past Littlehampton. In this district also I have taken all the three forms, but those with the long antennæ very sparingly—the latter circumstance suggesting the conjecture that the adult males are less littoral in their habits than the females. My search, in company with a friend, was continued almost every

day for nearly a fortnight; and, unless where here and there weeds and stones afforded a shelter, these extensive sands yielded no other sessile-eyed Crustaceans except *Bathyporeia*, *Eurydice pulchra*, and one single small specimen of *Sulcator*. This solitary specimen we took within the first five minutes, and expected accordingly to meet with the same abundance of the species as in Wales, but, with the most eager and anxious search, during all the rest of the time could never find another in the southern locality. *Bathyporeia pilosa*, on the other hand, could have been taken in thousands. Its presence beneath the sand is betrayed by a small furrow, sometimes short and nearly straight, ending in a little pit, at others twisting and meandering about and occasionally zigzagged. The mothers with young look as if their bodies were tinted with a delicate blue; but this is due partly to a double stripe upon each ovum, the colouring of which is seen through the pellucid sides of the parent, and partly perhaps to the contents of the alimentary canal.

In the sands at Paignton, near Torquay, I have taken in close proximity to one another the sand-furrowers *Sulcator arenarius*, *Kröyera arenaria*, *Bathyporeia pilosa*, and *Eurydice pulchra*.

#### EXPLANATION OF PLATE III.

- Fig. 1.* *Bathyporeia pilosa*, not full-grown.  
*Fig. 2.* The same, adult male.  
*Fig. 3.* Upper antennæ.  
*Fig. 4.* First gnathopod.  
*Fig. 5.* Second gnathopod.  
*Fig. 6.* Third pereopod.  
*Fig. 7.* Fourth pereopod.  
*Fig. 8.* Upper portion of fifth pereopod.

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XI.—*Descriptions of five new Species of Fishes obtained in the New-Zealand Seas by H.M.S. 'Challenger' Expedition, July 1874.* By JAMES HECTOR, M.D., C.M.Z.S.

#### *Trachichthys intermedius*, sp. n.

P. 16. V. 1 | 6. D. 6 | 11. A. 3 | 10. L. lat. 28.  
 L. transv. 6/10. Caudal 7 | 10 | 6.

Body compressed. Length of head nearly equal to the height, and contained twice and a half in the length (without caudal, which is equal in length to the head). Pectoral extends behind the vent, being same length as caudal, and has the



fourth lowest ray longest. Ventrals slightly in advance of pectorals and reaching to the vent, which is behind the middle. Snout rounded, its length being one half the diameter of the orbit. Cleft of mouth very oblique. Maxillaries expanded behind, and twice the diameter of the orbit in length. Teeth in fine villiform bands. Interorbital space equal to the orbit, prismatic, with a lozenge-shaped space on each side separated by a double elevated ridge that terminates in two spines over the nostrils in front, and diverges behind to bound an occipital space. The upper part of the head is formed of a delicate framework and membranes enclosing large cavities. The infraorbital area is crossed by seven rays, and the operculum by two vertical ridges with five transverse bars, the lowest being prolonged over the suboperculum and angle on the gill-opening as a roughly serrated spine. Between the occiput and commencement of the dorsal is a rough elevated ridge. The posterior dorsal rays rest in a groove. The caudal is deeply forked, each lobe of ten soft rays with seven sharp spines above and six below. The dorsal and anal fins end at the same vertical line; and the interspace to the caudal is equal to half the length of the body. The greatest height is vertical to the commencement of the dorsal. The serrated ventral keel consists of ten scales.

Colour silvery white, except the tips of the dorsal fin and caudal lobes, which are darkened by crowded black spots; the neck, back, and base of caudal have also a dark shade from the presence of minute spots. The scales above the lateral line are rough and adherent, but below are soft and deciduous.

Total length 2·7 inches, height ·85.

Dredged by the 'Challenger' Expedition in 400 fathoms off Cape Farewell.

This fish approaches *T. elongatus*, Günth., of which a single specimen was obtained at the Great Barrier Island; but from its having evidently intermediate characters between that species and *T. australis*, I have distinguished it under the above name.

*Platystethus abbreviatus*, sp. n.

B. 5. P. 16. V. 1 | 6. D. 7 | 26. A. 2 | 26. L. lat. 80.  
L. transv.  $\frac{6}{20}$ . Caudal 3 | 14 | 3.

Body compressed; general form rhomboidal, the greatest length being vertical to the second dorsal spine, which is over the anal spine. Length equal to once and two thirds the

height, the head being two thirds of the height. Length of snout less than the diameter of the orbit, which is half the length of the head. Interorbital space equal to the snout, this being the greatest thickness of the body. The eyes are very high up; and on each orbit is a doubly serrated ridge that ends in a spine that projects forwards and covers the nostril; the inner branch of the ridge is continued backwards, bounding a deep interorbital depression, the outer is continued round the margin of the orbit. The lower jaw slightly projects. The upper jaw is formed of the intermaxillaries, the maxillaries depending vertically over the angle of the mouth and ending in a spinous process. The inferior edge of the lower jaw is serrate. Infraorbital space sealed, the opercles naked, with all the lower free edges serrate. A strong ridge with eighteen rough scales extends from the isthmus to the ventrals. The groove for the reception of the dorsal is bounded by twenty-six oblique spinous scales, and that for the anal by twenty similar scales, each having four minute spines, the first being the longest. The first dorsal spine is short, the second long, being half the length of the head; ventral spine the same length, the anal spine one third. The second dorsal spine is compressed, with a sharp anterior edge. Soft dorsal does not begin with a spine. The length of the caudal part of the body is equal to the orbital diameter, and has three short pointed spines above and below the base of the caudal, which is rounded. Scales very narrow and rough.

Colour silvery, with a black crescent behind the pectoral, which is very small and rounded. There is also a black line along the base of the dorsal and anal, and a patch on the base of the caudal.

Teeth very minute.

The depressed interorbital space, shorter form, and different number of fin-spines are the chief characters on which this fish is separated from the only other species of the genus, *P. cultratus*, of which only two specimens are recorded, from Norfolk Island.

Dredged by H.M.S.-'Challenger' Expedition in 400 fathoms off Cape Farewell.

*Scorpaena barathri*, sp. n.

B. 7. P. 18. V. 1 | 5. D. 11—1 | 10. A. 3 | 5. Muciferous pores 22. L. scales 65. L. transv. 7 | 20.

Length equal to thrice and one fourth the height and twice and two thirds the length of head. Teeth on the palatines, vomer, and jaws in fine villiform bands. General form com-

pressed elongate, with profile of head convex. Length of snout equal to diameter of orbit; maxillary rather longer. Interorbital space equals one third of the same. Supraorbital ridges with five spines. Præoperculum with five spines in the lower limb; suboperculum with two appressed spines on the upper limb. Third dorsal spine longest, and equal to half the length of the head. Anal spine of the same length, and greater than base of anal fin. The interval between the anal and caudal is twice that between the soft dorsal and caudal.

Colour silvery, with a yellow line and a few brown spots on the back, and a dark patch on the dorsal fin.

Approaches nearest to *S. panda*, Rich.; but is distinguished chiefly by the greater length and less height of the dorsal, and shorter pectorals.

Dredged by H.M.S.-'Challenger' Expedition in 400 fathoms off Cape Farewell.

*Macrurus armatus*, sp. n.

D. 11—65. A. 75. V. 7.

Length of head equal to half the length of the body before the anus and contained five times and a half in its total length. Greatest height at first dorsal ray not equal to the length of head. Second dorsal ray as long as the height of body; spinous anteriorly, and enveloped in a sheath that is prolonged as a filament, overreaches only half the distance to the second dorsal, the interspace of the dorsal fin being equal to two thirds the length of the head. Diameter of orbit is one fourth of the length of the head and equal to that of the snout, but exceeds the projection of the snout beyond the mouth by one third. Interorbital space is once and one third of the orbital diameter. First ventral ray is prolonged, and reaches to the vent. Teeth in a single series. Mouth wide, extending across four fifths of the inferior surface of the head. Scales with three feeble spines, the middle spine being granulated on the head- and neck-scales.

Colour uniform light grey.

Dredged by H.M.S.-'Challenger' Expedition in 400 fathoms off Cape Farewell.

*Pseudorhombus boops*, sp. n.

B. 5. D. 118. P. 11. V. 6. A. 93. C. 16. L. lat. 80.  
L. transv. 36.

Eyes on left side. Mouth and head otherwise symmetrical. Length equal to twice and a half the height and thrice the  
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length of the head. Lateral line arched over the pectoral fin, the length of which is one third the height and the same as that of the caudal, which is rounded. Left ventral fin in line with the anal, but not continuous. Length of maxillary is contained twice and two thirds in length of head and two thirds that of snout. Orbits separated by a narrow slightly elevated ridge that overhangs the lower orbit. Dorsal fin commences in front of eye, and one half the orbital diameter from snout. Opercular margin entire, except a shallow notch in front of pectoral. Præopercular limbs join at right angles. Cleft of mouth oblique; maxillaries extending to the anterior vertical of the upper eye. Every part covered with scales, the diameter of which is one third that of the profile, with the free margins ciliate. Teeth in a single row, on both jaws in equal number, there being six on each side above and below; none on the vomer. Lower jaw with a prominent gonyx.

Colour yellowish white above, white beneath.

Differs from *P. scaphus*, Forst., to which it is closely related, in the number of rays, and in the greater relative size of the head, and the strikingly large orbits.

Dredged by H.M.S.-'Challenger' Expedition in 400 fathoms off Cape Farewell.

## XII.—On a new Motella from Norway.

By ROBERT COLLETT.

### *Motella septentrionalis*, n. sp.

2. D. 50-51. A. 41-43. P. 15-16. V. 7. C. 28-30.

Body rather short; head large, depressed, contained four times in the total length (including caudal). Snout obtuse, with one barbel at each of the nostrils, and a row of eight shorter or rudimentary ones along the upper lip, one at the chin. Upper jaw considerably longer than the inferior. The maxillary extends far behind the posterior margin of the orbit (the central point of iris is rather nearer the extremity of the snout than the end of the maxillary). Teeth cardiform and of unequal size. The eyes are rather small and directed upwards; the orbit is contained seven times and a half in the length of the head (in younger individuals six times). First dorsal short, its first ray short, only twice as long as the orbit. The vent is situated in the middle between the extremity of the snout and the end of the anal. The lateral line for the most part conspicuous, consisting of about eighteen large pores.

Coloration brown, without traces of spots. The total length of the largest examined specimen 170 millims.

I possess two specimens from the western and northern coasts of Norway, both brought up in a dredge by Prof. G. O. Sars searching for sea animals. The larger specimen (total length 170 millims.) was taken at Florö, on the Bergen coast, in 1873; the other is a younger individual (total length 100 millims.), and taken from a depth of 30 fathoms at Bodö, north of the Arctic Circle (lat. 67° 15' N.), in 1874.

Christiania, November 10, 1874.

## MISCELLANEOUS.

### *On the Embryogeny of the Rhizocephala.*

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

GENTLEMEN,—In your Journal for November 1874, p. 383, M. Giard imputes an error to me of which I am not guilty. He says:—"An error similar to that of M. Gerbe has been made by Professor Semper, who describes as furnishing a larva of a *very* peculiar form a *Peltogaster* of the Philippine Islands, of which he has *evidently* observed the embryos only after the first moults, when they already affected the Cypridine form."

I trust you will be so kind as to allow me to offer some remarks on this matter.

Having observed the Cypridine larva of a *Peltogaster* in the Pelews already in 1861, and having sent my few remarks on them to the editor of the 'Zeitschr. für wiss. Zool.' in 1862, which appeared in 1863, I was evidently unable to know that F. Müller would describe in the year 1863 (Arch. f. Naturgesch. xxix. Febr.) the second larva of the Suctoria: at that period only the first of them, the *Nauplius*-form, was known. I was thoroughly justified, therefore, in designating a larva diverging from the only known ones as being *peculiar*; I might then have called it rightly *very* peculiar, although I have not done so. It was peculiar not only for its unknown form, but also for its two eyes, whilst the larvæ of *Rhizocephala* till then known had only a single one.

M. Giard imputes to me an error on the ground of his belief that all *Rhizocephala* *must* have a *Nauplius*-larva as the first larval stage. But this is only a dogma. M. Giard has not examined the species discovered by me in the Pacific; he has therefore no formal right to impute to me a mistake in my observations. In the totally closed sac of the mother only such Cypridine larvæ were found, no *Nauplius*-larvæ or empty skins which I might have ascribed to such. Why, then, should not here, as is the case with so many other crustaceans,

the development of one species have been shortened? M. Giard communicates no observations which might prove the impossibility of such a shortening of the development. Consequently I maintain my view that the species described since by Dr. Russmann under the name of *Thompsonia globosa* (Verhandl. d. phys.-med. Gesellsch. zu Würzburg, 1872, oder Arbeiten aus dem zoologisch-zootomischen Institut zu Würzburg, Band i. p. 131), after my drawings and specimens, has larvæ which leave the egg only in the Cypridine form. There is even no stringent reason to take it for granted, as M. Giard not very judiciously seems to do, that they undergo a conspicuous change of form within the egg, although this, of course, remains to be ascertained.

Yours very truly,

Würzburg, November 20, 1874.

Prof. C. SEMPER.

*On the Circulatory Apparatus of the Echinida.* By M. E. PERRIER.

The circulatory apparatus of the Sea-Urchins has been the subject of numerous investigations, which are summarized in Valentin's monograph on *Echinus lividus*, and more recently in the fine monograph of the Echinida by Mr. Alexander Agassiz. These various researches have left very doubtful even the most important points in the arrangement of the vascular apparatus. We can regard as certain only these two facts:—1. The existence of an intestinal vascular apparatus. 2. The existence of a system of vessels communicating with the ambulacral canals, and usually designated by the name of the aquiferous apparatus. We did not even know whether these two systems of vessels were distinct, or whether they communicated with each other. This communication, imperfectly seen by Louis Agassiz, and since sought in vain by many anatomists, has only been met with again quite recently by Hoffmann in the *Spatangi* and *Toxopneustes*, belonging to the regular Echinida. But there were still many questions to be solved:—The mode of vascularization of the test indicated by some authors seemed very doubtful. The structure of the heart, or at least of the organ so called by anatomists, remained very obscure; moreover there was occasion, in the presence of contradictory statements, to verify the announced results, to group and coordinate, and finally to present a complete and homogeneous description of the circulatory apparatus of the Echinida.

This is the problem which I have endeavoured to solve during a stay of several weeks at the laboratory of experimental zoology of M. de Lacaze-Duthiers at Roscoff (Finisterre).

The dredging-operations instituted by M. de Lacaze-Duthiers at his laboratory brought in every day with certainty a great number of specimens of *Echinus sphaera*, which, in consequence of their considerable size, were particularly well adapted for my investigations, the results of which may be summarized as follows:—

Beneath the madreporic plate a canal (the sand-canal) originates, which descends vertically towards the lantern, passing along the œsophagus to the left and behind. This vessel and the œsophagus are united by a mesenteric lamina which embraces the organ hitherto known

as the heart, to which the vertical canal is intimately united, but without having any relations to it except those of contiguity. The organ in question is *therefore not a heart*, as has hitherto been believed; and we shall recur immediately to its structure. Having arrived at the point where the œsophagus penetrates into the lantern, the vertical vessel opens into a circular vessel resting on the superior membranous floor of the lantern and bearing opposite to each of the pyramids a small racemiform gland (Poli's glands). This, whatever may have been said, is the only vascular ring presented by the circulatory apparatus of the Echinida; at least I have found it impossible to discover any other. From this ring, opposite to the intervals of the pyramids and consequently alternating with Poli's glands, spring five radiating vessels which pass beneath the calcareous piece known as the *falx*, and become widened so as to occupy the whole width of the inferior surface of this piece. Arriving at the outer margin of the lantern these radiating canals resume their original calibre and run along the outer surface of the lantern, from which, however, they finally separate, so that each of them may become continuous with one of the five ambulacral canals. The latter are produced a little towards the mouth beyond their point of junction with the five vertical canals; it is this, no doubt, that has led to the belief in the existence of a vascular ring applied to the buccal membrane within the lantern; but this ring has no existence: the prolongations of the ambulacral canals soon bifurcate; and each of their branches penetrates into one of the two large buccal tentacles.

The ambulacral canals ascend along the test, and *terminate cœcally* below the pore presented by the so-called *ocular* plates, although these do not contain any organ of vision. In *Echinus sphaera* this pore is closed by a continuous membrane, and does not give passage to any thing resembling an unpaired tentacle. Although one can inject the whole circulatory apparatus by applying to one of these pores the pipe of a syringe, there is not in it any direct communication between the vascular apparatus and the exterior; the injection only penetrates in consequence of a lesion. There is no anal ring uniting the five ambulacral vessels. Each canal is the seat of a double current maintained by the vibratile cilia which clothe its interior; it serves at once for the flow and the return of the sanguine liquid which it contains, as I have been able to ascertain by direct observation. The arrangement of the ambulacral vessels of the Echinida therefore exactly reproduces that which I have already described in the *Comatulæ*.

Immediately opposite to the right upper Poli's gland there springs from the circular vessel of the lantern a vascular branch which ascends along the œsophagus, and forms, to a certain extent, a pendant to the vertical canal which originates from the madreporic plate and opens at the left posterior Poli's gland. Having reached the point where the œsophagus opens into the intestine, this canal becomes reflexed and considerably widened, and constitutes the great vessel which follows the inner margin of the intestine, and beyond which the mesenteric plate is slightly prolonged. There is con-

sequently a real communication between the intestinal vascular apparatus and the supposed aquiferous apparatus. The inner vessel is separated from the intestine proper by the singular canal which I propose to name the *intestinal siphon*, which, originating from the upper extremity of the œsophagus, runs to open into the intestine a little before its point of reflexion, and which, according to certain observations, would seem to be destined for the rapid conveyance of sea-water into the second bend of the intestine. Beyond the point where this canal opens into the intestine, the vessel which accompanies it widens into a great reservoir, from which issue numerous vascular branches passing to the intestine. This reservoir is produced a little upon the reflected part of the mesentery; but it soon diminishes in volume, and becomes very rapidly resolved into a network of capillaries, which may be traced for a considerable distance upon the mesentery; the inner vessel therefore is not prolonged as a distinct vessel upon the second bend of the intestine.

All along its course the vessel which has just been described emits numerous branches which pass to the intestine and constitute the afferent branches of a very rich and elegant capillary network, the efferent branches of which pass to a trunk passing along the outer margin of the intestine, the external marginal trunk. This trunk is continued into the mesenteric plate; we have never seen it emitting even the smallest branch passing to the test. We do not see what return course could be taken by the blood which might get into these branches; and it is evident that the external and internal marginal vessels constitute the two principal trunks of an isolated intestinal vascular system, completed by the capillary network. This circle being thus closed there can be no question of branches opening towards the test, unless it be possible to close it again. The external marginal vessel is prolonged further upon the second bend than the internal vessel; but it also diminishes very rapidly and does not reach the anus. I have not been able to follow it to the ring of the lantern; the injection is always arrested at the origin of the œsophagus. Moreover, if this vessel were prolonged as far as the lantern, it would necessarily terminate at the same point as the vertical canal, which is not very probable.

In its festooned course along the first bend this vessel splits so as to form a thick, nearly circular trunk, which communicates with it by its two ends, one situated close to the stomach, the other close to the point of reflexion of the intestine. Six vertical branches, at nearly equal distances apart, also make a communication between the marginal vessel and this circular vessel, which floats freely in the liquid of the general cavity, and enjoys, like the marginal vessels, a very marked contractility, although this did not appear to be rhythmical.

The histological investigation of the supposed heart showed that this organ was nothing but a true gland, the product of which is poured into a tubular cavity situated below the vertical canal starting from the madreporic plate. This cavity is prolonged into an excretory duct, opening also at the infundibuliform space enclosed



between the membrane of the test and the madreporic plate. Other tubular glands, situated on the opposite side of the œsophagus, in the thickness of the mesentery itself, open in part with this excretory duct, and in part directly beneath the madreporic plate, the pores of which probably give issue to the secreted liquid. It is to be observed that, by the intermediation of the infundibuliform space situated below the madreporic plate, the circulatory apparatus and this glandular apparatus communicate with each other, so that an injection driven through the supposed heart may descend again through the sand-canal.

In the Spatangidæ (*Amphidetus*), which have been said to have no trace of a heart, I have found a gland exactly similar to that which hitherto has been regarded as the heart in the Echinida.

Lastly, I have ascertained, by varied experiments, that the water which fills the cavity of the test of the sea-urchins can only penetrate them slowly and by endosmose, either through the buccal membrane or through the ambulacral tubes. When sea-urchins have lived for some time in sea-water coloured with aniline, we very regularly find the entire œsophagus and the siphon by which it communicates with the point of reflexion of the intestine coloured red. There has consequently been an introduction of water into the intestine by this course, and a possible passage of a part of this water into the general cavity through the walls of the digestive tube. — *Comptes Rendus*, November 16, 1874, tome lxxix. pp. 1128-1132.

*Embryology of the Ctenophora.* By ALEXANDER AGASSIZ.

The question of the systematic position of the Ctenophora can now, thanks to the greater knowledge we have of their embryology, be treated more intelligently. The position taken by Vogt, who follows Quoy in removing them from the Acalephs altogether, and associating them with the Mollusks on account of the apparent bilaterality so strongly developed in some families (*Cestum*, *Bolina*, and *Mertensia*), seems not untenable. The nature of their relations to Echinoderms, Polyyps, and Acalephs, as well as the general relations of the Cœlenterata to Echinoderms, may be discussed again, especially as having an important bearing not only on the value of the Cœlenterata as a primary division of the animal kingdom, but also on the limits of the Radiata, and the possible affinities of the Sponges and Cœlenterata suggested by Hæckel\*. A still more important point developed from this embryology is its connexion with the *Gastrœa* theory of Hæckel†, for which he claims that it will supplant the type theory, and give us in its place a new system based upon the homology of the embryonic layers and of the primitive digestive cavity. Hæckel attempts, in his *Gastrœa* theory, to find an explanation for the natural development of species from a purely mechanical cause, and has been bold enough not only to

\* E. Hæckel, 'Die Kalkschwämme,' Berlin, 1872.

† E. Hæckel, "Die *Gastrœa*-Theorie," *Jenaische Zeitschrift*, ix. 1874.

name, but also figure, the primitive ancestor from which all types of the animal kingdom have been developed! This unknown ancestor, he says, must have been built much like his *Gastrula* (only another name for what has long been known to all students of Invertebrates as the *Planula* of Dalyell). Hæckel would lead us to believe that this *Gastrula* is a newly discovered embryonic stage; all he has done in reference to it is to recall the existence of *Planule* among Sponges, which had previously been discovered by N. Miklucho-Maclay\*. Since the publication of Hæckel's article, his special interpretation of fanciful affinities and homologies existing only in forms conjured up by Hæckel's vivid imagination, have been sufficiently criticised by Metschnikoff†; so that until we know something more of the development of Sponges we may leave the discussion of their affinities with Cœlenterates out of the question, in spite of the ingenious arguments advanced to support Leuckart's views on the subject.

The existence of *Planule*, the walls of which consist of an ectoderm and entoderm, has been distinctly proved for Aculephs, Echinoderms, Polyps, Worms, Arthropods, Tunicates, Mollusks‡, and finally for *Amphioxus*; the papers of Johannes Müller, Krohn, Agassiz, Kowalevsky, Sars, Allman, Claparède, Kupfer, Metschnikoff, and others are too well known to need citation in this connexion. So far we are in perfect accordance with Hæckel and cordially agree with him in his estimate of the systematic value of this early embryonic stage, whether we call it *Planula* or adopt his latter name of *Gastrula*. But let us follow his subsequent steps and separate what is known from what is stated as known by Hæckel. It is known that the *Planula* consists of an entoderm and of an ectoderm. It is known that the primitive digestive cavity is, in the case of Echinoderms, of Ctenophora, and of some Discophora, formed by the turning-in of the ectoderm, so that the wall of this primitive cavity is, in their case at least, invariably formed by the ectoderm. It is known, on the other hand, that in Actiniæ, in Worms, in Hydroids§ this primitive digestive cavity is hollowed out of the inner yolk mass of the embryo, and has its walls formed by the entoderm. We must lay great stress on this point, which is alluded to by Hæckel as of no consequence; for this seems to us to destroy the very base of his argument. If the *Gastrula* can in one case, and in such closely allied classes as Actiniæ and Hydroids on one side, and Echinoderms and Ctenophora on the other, be built so differently that in the first case the walls of the primitive cavity are formed by the entoderm, and in the other of the ectoderm, what becomes of all

\* N. Miklucho-Maclay, Jen. Zeitschrift, iv. 1868.

† E. Metschnikoff, "Zur Entwicklungsgeschichte d. Kalkschwämme," Zeits. f. wiss. Zool. xxiv. 1874.

‡ E. R. Lankester, "On the Primitive Cell-layers of the Embryo," Ann. Mag. N. H. May 1873.

§ H. Fol, "Die erste Entwicklung d. Geryonidenesies," Jen. Zeitsch. vii. p. 471.

¶ Hæckel and Lankester both seem to think that because the result is a similar form it must be homologous.

his subsequent generalizations of the value for systematic purposes of these two layers? The distinction of entoderm and ectoderm is, as Hækel himself acknowledges, and as is sufficiently shown by Kowalevsky, of the greatest anatomical value; yet how is it possible that these differently constructed *Planulae* should have the genetic connexion claimed for them by Hækel, if in their very embryonic stages the differences are of so radical a nature that, according to the very theory of embryonic layers so strongly insisted upon by Hækel, they could have no possible relation, the one being a product of the entoderm, the other of the ectoderm, the two primitive embryonic layers?

It is not known, as is stated by Hækel, that the walls of the primitive digestive cavity are invariably formed of the entoderm; and when Hækel states the result (the *Gastrula*) to be the same whether formed by the ectoderm or entoderm, he states what is known to be exactly the contrary. It is not known, as is stated by Hækel, that the mere fact of a *Planula* fixing itself by one extremity or not, will in one case lead to a radial type, in another to a bilateral type. What becomes of all the free-swimming embryos of Echinoderms, of Acalephs, of Polyyps? Are they bilateral? It is true Hækel is obliged, to suit his theory, to consider the Echinoderms as an aggregation of individuals; but he has not the countenance of a single zoologist whose opinion on Echinoderms is of any value. When he says that Sars, whose knowledge of the development of Echinoderms was so accurate, agreed with his peculiar views, we can only reply that his agreement must be based upon a misunderstanding. We have equally as many radial and bilateral types developed either from fixed or from pelagic *Gastrulae*; and to cite this as a *causa efficiens*, the mechanical reason of the genetic descent of all radiates from a fixed *Gastrula*, and of all bilateral types from a free-swimming one, is simply fantastic. How is it that so many Actiniæ and Acalephs have their radiate structure developed long before they become fixed? It is not known that the embryonic layers of Acalephs are truly homologous to those of the higher Vertebrates. Huxley simply speaks of their bearing the same physiological relation to one another; but until we know the *Gastrula* of other Vertebrates than *Amphioxus* it is idle to talk of the continuity existing between the ontogeny of *Amphioxus* and the remaining members of the Vertebrate branch, and to say that hence there is *no doubt left* that the ancestors of the Vertebrates must, in the beginning of their development, have passed through the *Gastrula* form! Neither Hækel nor any one else has seen this; it is a pretty hint which may or may not be proved.

Considerable confusion arises in Hækel's classification from his adopting at one time as of primary importance the development of the cavity of the body and making it the main point in his phylogenetic classification, while previously the relations of the phylum to *Protascus* and *Prothelmis* (names he gives to the unknown ancestors of the radial and bilateral types) formed the basis of his classification. This places him in the awkward predicament of having a phylum of the animal kingdom (the radial) which has lost the

capacity of forming a body-cavity, and yet its descendants have in some unaccountable manner (entirely against the rules of Hæckel's theory) managed to get one by some unexplained method. We do not see how it can be so confidently stated by Hæckel that Echinoderms have lost their original central nervous organ; there is no proof whatever of its once having existed. There is as yet no proof whatever that the organs of sense (which, as had already been so often insisted upon by Agassiz, are not homologous in the different branches of the animal kingdom) have the same phylogenetic origin. When Hæckel says that the mouth of Echinoderms is not homologous to the primitive mouth, we can only refer him to the memoirs of Müller, Metschnikoff, and myself on Echinoderm embryos for proof to the contrary.

There seems no doubt, as Hæckel insists, that to the majority of zoologists of the present day the idea of type is a very different one from that of type as understood by Baer and Cuvier. The probability of their original community of origin is hinted at from the many so-called intermediate forms, both living and fossil, which, though we may enroll them either in one great branch of the animal kingdom or another, yet show that we can no longer consider the great types of the animal kingdom as closed cycles, but must hereafter regard them as holding to one another relations similar to those which the remaining categories of our systems have to one another. This change has principally been brought about by a better knowledge of the embryology of a few well-known types.

But what becomes of all the assumptions of Hæckel which form the basis of his *Gastræa* theory? They are totally unsupported; and with their refutation must fall his theory; it can only take its place by the side of other physiophilosophical systems; they are ingenious arrangements laboriously built up in the interests of special theories, which fall to the ground the moment we test them by our actual knowledge. That the time has not yet come for embryological classifications, the attempts of Hæckel plainly show; for they are in no wise in advance of the other embryological classifications which have preceded them: we get new names for somewhat different combinations; but a truly scientific basis for a classification based upon the value of embryonic layers is at present impossible; such attempts can be only speculations, to be proved or disproved on the morrow.

What Hæckel substitutes in the place of the accepted types of the animal kingdom is simply another view of these same types; and his *Gastræa* theory is in no danger of upsetting, at present at least, zoological classification as now understood. Indeed, if we need an ancestor for our phylum, why not at once go back to the cell? There we have a definite starting-point, a typical element which underlies the whole of the animal kingdom, and which forms the walls of Hæckel's *Gastrula*. Then we shall all be agreed; and when we frankly state that all organisms are derived from a primitive cell and from its subsequent increase, we come within the range of positive knowledge, but we are unfortunately as far as ever from having for that reason been able to trace a mechanical

cause for the genetic connexion of the various branches of the animal kingdom. We must meet the direct issue raised by Hæckel (that such a genetic connexion either does or does not exist) by repeating what has so often been said by others:—This genetic connexion may exist; but we have at present no proof that it does exist. And, at any rate, his *Gastræa* theory does not bring us any nearer to a mechanical explanation of such a genetic connexion, however probable it may be. . . . .

Here we must call attention to a marked difference between *Acalephs* and *Polyps* on one side, and *Echinoderms* on the other—that while in the former the connexion between the digestive cavity and the water-system always remains open, it is at one time disconnected in the *Echinoderms*, though it is eventually reopened through anastomoses of the water-tubes. The anal opening holds in *Ctenophora* very much the same relation which it holds in *Echinoderm* larvæ, in which the water-tubes are still connected with the primitive digestive cavity. When we find, as we do, that in *Ctenophora*, as well as in *Echinoderms*, the primitive digestive cavity is formed by the inturning of the ectoderm, that in both classes the water-system is developed as diverticula from this digestive cavity, we fail to see how we can separate the *Ctenophora* from *Echinoderms* and place them with *Polyps* in a separate subkingdom of the animal kingdom. No one questions the relationship of *Ctenophora* to *Acalephs*; yet from embryological data it would be more natural to associate *Echinoderms* and *Ctenophora* into one subkingdom, characterized by the mode of formation of the water-system as diverticula forming eventually chymiferous tubes in both classes, and to associate the other *Acalephs* with the *Polyps*\*, where the chymiferous tubes and cavities are formed by the liquefaction of the interior of the *Planula*. Any one who will compare the figures of the embryos of starfishes (A. Agassiz, *Embryol. Starfish*, pl. ii. fig. 8) and *Ctenophora* (pl. iii. figs. 6–10, pl. v. figs. 5, 11) at the time when the chymiferous tubes are reduced to mere diverticula, cannot fail to feel satisfied of their complete identity of plan. Metschnikoff has made, in addition to the homologies I have just recalled, a most interesting comparison between an *Echinoderm* larva and a *Ctenophore*; he shows that, even in the adult *Ctenophore*, the identity of plan is not destroyed, and is carried out to the smallest details. The only point in which I would differ from him is in his comparison of the abactinal cœliac openings to the actinostome: he seems to forget that in *Echinoderm* larvæ what at first performed the part of anus and mouth eventually becomes the mouth alone; so that his figures should be reversed, and then the identity will be found complete between an *Echinoderm* larva (see A. Agassiz, *Embryol. Starfish*, pl. iii. fig. 6, and pl. vii. fig. 8) with its œsophagus, digestive cavity, alimentary canal and its chymiferous pouch (water-system), from which run the diverticula eventually to become the water-tubes,

\* See Allman's views on the position of the *Ctenophora* as contrasted with the *Actinozoa*, *Trans. R. S. Edinb.* xxvi. pt. ii. p. 466, 1871.

and a Ctenophore (pl. iii. fig. 25) with its lateral tubes on the sides of the digestive cavity (*g*), leading into the chymiferous pouches (*w*), branching into the chymiferous tube. The cœliac openings (pl. iii. fig. 45, *ca*) of the funnel he looks upon as representing the madreporic body, while I look upon them as the anal openings. In this view of the case, the Ctenophore is rather more in the embryonic condition of the Echinoderm larva, when the actinostome leading into the digestive cavity should perform at the same time the function of mouth and anus, which it occasionally does, although at other times the cœliac opening of the funnel seems to be the true anal opening, while, according to Metschnikoff, it is the madreporic body which performs the part of an anal opening. He says it only acts to introduce water into the system, which is contrary to my observations.

I may here recall former statements\* concerning the affinities of the Ctenophora, when describing some of the younger stages. It could only be after a careful comparison of Ctenophorous and Echinoderm embryos that undoubted evidence of their identity of plan might be obtained. The Ctenophora retain the permanently embryonic features of Echinoderm embryos, in which the water-system is still connected with the digestive cavity. The formation of a funnel as a sort of alimentary canal, opening externally through the cœliac apertures at the abactinal pole, corresponds to the existence of a short alimentary canal in Echinoderm larvæ. The Ctenophora are, from their embryology, more closely related to the Echinoderms than to the other Acalephs; and it seems natural to separate the Acalephs into two orders—the Ctenophora, characterized by the presence of locomotive flappers, and the Medusidæ, including the Discophora and Hydroids.—*From the Memoirs of the American Academy of Arts and Sciences*, vol. x. no. iii., August 1874.

*Notice of Papers on Embryology by A. Kowalevsky.* By A. AGASSIZ.

A. Kowalevsky has published, unfortunately in Russian, two capital papers on embryology. The one continues the investigations he had been carrying on regarding the existence of an ectoderm and entoderm layer in the early embryonic stages of Invertebrates. In the present paper he has given a summary of the early stages of a *Campanularia*, confirming the observations of Wright and A. Agassiz. For *Rhizostoma* and *Cassiopea* he shows that the digestive cavity is formed by the invagination of the ectoderm. This is contrary to the results of previous observers, except Schneider. For *Pelagia* he shows a direct development from the egg remarkably similar to that of the Geryonidæ as we know it from Hæckel, Fol, and Metschnikoff. He adds nothing to the embryology of Actinia not already known from the magnificent monograph of Lacaze-Duthiers. He then passes on to the development of *Acyonium*, of which he gives an extremely interesting sketch supplemented by fragments on the embryology of *Astræa*, *Gorgonia*, and *Cerianthus*: the development of the latter is strikingly similar to that of *Edwardsia*, as we know it during its passage from *Arachnactis* to *Edwardsia*. He

\* Alexander Agassiz. Ill. Cat. M. C. Z. no. 2, p. 12, 1865.

has added a few observations on the earlier embryonic stages of *Eschscholtzia*, *Beroë*, and *Eucharis*, completing deficiencies in his earlier papers on the embryology of Ctenophora. These supplementary observations agree completely with the observations of A. Agassiz on the embryology of Ctenophora.

The second memoir is a very complete history of the development of Brachiopods, strikingly in accordance with the views of Steenstrup and of Morse on the affinities of Brachiopods with Annelids. The homology between the early embryonic stages of *Argiope* and well-known Annelid larvæ is most remarkable; and the resemblance between some of the stages of *Argiope* figured by Kowalevsky and the corresponding stages of growth of the so-called Lovén type of development among Annelids is complete. The number of segments is less; but otherwise the main structural features show a closeness of agreement which will make it difficult for conchologists hereafter to claim Brachiopods as their special property. The identity in the ulterior mode of growth between the embryo of *Argiope* and of *Balanoglossus* in the *Tornaria*-stage is still more striking: we can follow the changes undergone by *Argiope* while it passes through its *Tornaria*-stage (if we may so call it) and becomes gradually, by a mere modification of the topography of its organs, transformed into a minute pedunculated Brachiopod differing as far from the *Tornaria*-stage of *Argiope* as the young *Balanoglossus* differs from the free-swimming *Tornaria*. In fact, the whole development of *Argiope* is a remarkable combination of the Lovén and of the *Tornaria* types of development among Worms. His paper also includes the history of a less vermiform type of development, that of *Thecidium* and of *Terebratulina*, in which the observations of Kowalevsky fully agree with the previous well-known memoir of Lacaze-Duthiers on *Thecidium*, and of Morse on *Terebratulina*. It is not out of place to recall the very ungenerous treatment which Morse received at the hands of many conchologists for the heresies of his papers on the systematic position of Brachiopoda; and it certainly is a striking proof of the sagacity of Morse, to have announced so positively, from the history of the American Brachiopods alone, the vermiform affinities of Brachiopods, now so conclusively proved by the development of *Argiope* in Kowalevsky's paper.

The close relationship between Brachiopods and Bryozoa cannot be more fully demonstrated than by the beautiful drawings on pl. v. of Kowalevsky's history of *Thecidium*. We shall now have at least a rational explanation of the homologies of Brachiopods, and the transition from such types as *Pedicellina* to *Membranipora* and other incrusting Bryozoa is readily explained from the embryology of *Thecidium*. In fact, all incrusting Bryozoa are only communities of Brachiopods the valves of which are continuous and soldered together, the flat valve forming a united floor, while the convex valve does not cover the ventral valve, but leaves an opening more or less ornamented for the extension of the lophophore\*.

—*Silliman's American Journal*, Dec. 1874.

\* Mr. B. P. Mann translated for me the explanation of the plates of the two memoirs of Kowalevsky.

*On the Relationship of the Vertebrata and Annelida.*

By C. SEMPER.

It is well known that the Ascidia are regarded with Kupfer and Kowalevsky as the nearest relatives of the Vertebrata; and this opinion is supported by the analogous mode of production of the nerve-cord and the presence of a chorda between it and the intestine in both groups of animals. But it is forgotten that the Vertebrata are segmented animals, while the Ascidia are not so: the sole indication of a segmentation in the latter appears to lie in the occurrence of spinal nerves in the tail and hinder part of the body of the larva of *Ascidia mentula*, as affirmed by Kupfer.

This gap is now filled in a most unexpected manner by the discovery of segmental organs in Selachian embryos. In *Acanthias*, *Centrina*, and *Scyllium* I have found funnel-shaped openings leading into ciliated ducts in connexion with the primitive kidneys; they are placed, one pair in each segment (*metamere*), right and left of the mesentery, along the whole of the body-cavity. They are produced by depression of the peritoneal epithelium, and are only secondarily connected with the lateral canals of the primitive renal duct, which also issue segmentally. The funnels in *Acanthias* are very large; and their cilia vibrate strongly. In *Centrina* and *Acanthias* they may be detected by the lens even in nearly mature embryos; in *Scyllium*, on the contrary, they disappear very early. In *Acanthias* the ovary is developed without any participation of the segmental organs; but in the male the seminal duct seems to become developed by a peculiar process of budding and amalgamation of the segmental funnels.

Except in a single point, the comparison to the segmental organ of an annelide may be completely carried out. In the one, as in the other, they are repeated in pairs in the segments of the body: they have a ciliated funnel opening freely into the cavity of the body; the ciliated duct springing from this leads into a glandular segment (in the Vertebrates to the Malpighian body or primitive kidney); they are in intimate relation with the genital organs; and, lastly, they are produced in their glandular and infundibular portion from the mesoderm. The sole distinction consists in the mode of opening of these excretory organs: in the Annelida each segmental organ opens separately in the corresponding segment of the body; in the Vertebrata they unite with the primitive renal duct, which in the Selachia, as in the Teleostea, is a product of the peritoneal epithelium. This contradiction cannot, however, be used as an argument against the comparison of the two sets of organs, as the union of the glandular part with the efferent ducts is in both cases produced secondarily by the coalescence of the original separate rudiments; moreover the so-called aquiferous vessels of the Rotatoria are universally compared to the segmental organs of the Vermes, although in the former, just as in the Vertebrata, two efferent ducts opening into the cloaca take up the secretion of the glands, which open by several funnels into the body-cavity.

It might appear that a statement of Gegenbaur's is to be referred



to these segmental organs. In his so-called 'Comparative Anatomy' he speaks of the possibility of a comparison of the oviducts and tubæ to the segmental organs of the Vermes. This is completely refuted by the observations here given: the true segmental organs of the Vertebrata (hitherto detected only in the Selachia) have nothing to do with the tubæ and the oviduct; the former originates from the primitive renal duct, and the latter is produced by a fold which finally leads to the formation of a tube; the tubæ are only the permanently open orifices of the primitive renal groove, and they consequently originate in quite a different manner from the true segmental funnels.

The comparison here made leads to far-reaching consequences. Assuming it to be correct, it follows that the Annelida are more nearly allied than the Ascidia to the Selachia, and therefore also to the Vertebrata in general (with the exception of *Amphioxus*). It might be objected that the spinal cord and the chorda are of more importance for the recognition of relationship than the primitive kidney and the segmentation of the body, so that the Ascidia are more nearly allied than the Vermes to the Vertebrata. But this objection is partly refuted by the circumstance that according to Kowalevsky's investigations the ventral cord of the Vermes and Insecta is formed in a perfectly analogous manner to the dorsal cord of the Vertebrata. The chorda alone seems to offer any difficulty; but it is still questionable whether the chorda of the Ascidia is really to be compared so unconditionally to that of the Vertebrata; and, on the other hand, Kowalevsky, in his 'Embryological Researches on Worms and Insects,' even indicated as a chorda a fibrous cord discovered by Leydig in the earthworm and detected by Claparède in numerous worms, and which in its origin and position between the ventral cord and the intestine exactly resembles the chorda of the Vertebrata. Nevertheless the histological structure of this cord is essentially different.

If the embryo of an annelide be turned so that its ventral surface lies upwards, its section presents exactly the same arrangement of the organs as in the Selachian embryo. Consequently, by the discovery of the segmental organs, the belly of the annulose animal is identified with the back of the vertebrate. This is not the place to trace this conception to its further consequences; in this respect, as also with regard to the detailed proof of the facts given above, reference must be made to a more complete memoir which will appear shortly in the second volume of the 'Arbeiten aus dem zoologisch-zootomischen Institut in Würzburg.'—*Centralbl. für die med. Wissensch.* 1874, No. 35.

Würzburg, July 1874.

#### *Segmental Organs in adult Selachia.* By C. SEMPER.

I can now follow up my former preliminary communication on the occurrence of segmental organs in Selachian embryos with a further statement that such organs may also be very easily detected even in adult animals, but only in fresh or very well-preserved

specimens. The Selachian genera in which I have regularly found them in sexually mature adult individuals are as follows:—*Squatina*, *Scymnus*, *Centrophorus*, *Spinax*, *Acanthias*, *Hexanchus* (in a specimen 10 feet long), *Pristiurus*, and *Scyllium*. In the last genera they are very small, and for the most part also altered; on the other hand, in *Scymnus* and *Squatina* they are exceedingly large, furnished with distinct funnel-shaped apertures, into which fine forceps may be conveniently introduced, and are present high up on the sexual fold. In *Squatina* especially these organs are so numerous, regularly developed, and striking even in the living animal, that it is quite incomprehensible to me how they can have been hitherto overlooked. The following genera are destitute of them when adult—*Lamna*, *Mustelus*, *Galeus*, *Carcharias*, and probably *Sphyrna*; when they disappear, or whether they occur at all in the embryo, still remains to be ascertained.

In my first communication I indicated that perhaps the seminal ducts originated from the segmental funnels. This is decidedly not the case; but, on the contrary, it seems probable, especially from their behaviour in *Squatina*, that the segmental ducts may become the *vasa efferentia testis*; and by a growth of the epithelium of the segmental funnels the epigonal organ may perhaps be produced. In favour of the supposition that the primitive renal duct becomes the seminal duct we seem to have the two facts:—that in large male embryos only a single canal is to be found, which subsequently becomes the urino-seminal duct; and, secondly, that a tuba occurs in the males of all genera of Rays and Selachia, and passes on each side into a canal exactly as in the females, and this evidently can be nothing but the anterior end of the primitive renal duct. The middle tubal orifice of the males is very large in many genera (*Scymnus*, *Centrophorus*, *Squatina*); the canals running backwards from it (representing the oviducts of the female) are very soon obliterated, and cannot be traced as such to the kidneys in the genera which have hitherto been investigated. In a few species, only a fine cord, but without a cavity, was recognized between the kidney and the hinder extremity of the male tubal canal. Careful investigations of the embryos have proved, however, that the permanent urino-seminal duct of the male is not the primary primitive renal duct, and that the latter disappears almost entirely in the region of the kidneys, whilst, as in the females, a secondary primitive renal duct has been developed as a urino-seminal duct. This is the case also in *Chimæra*. In the males of this species there are two isolated tubal openings which lead into a fine canal lying upon the urino-seminal duct; this corresponds in position to the oviduct of the female, and can be nothing but the primary primitive renal duct. By this *Chimæra* approaches much more closely to the Ganoids than to the Plagiostomi.

I hope soon to be in a position to follow up my first memoir, which has already been referred to and will shortly appear, on the segmental organs of the Selachia and the relationship of the vertebrate and invertebrate animals, with another on the urogenital system of the Plagiostomi.—*Centralbl. für die med. Wissensch.* 1874, no. 52.

Würzburg, Oct. 1. 1874.

# THE ANNALS

AND

## MAGAZINE OF NATURAL HISTORY.

[FOURTH SERIES.]

No. 86. FEBRUARY 1875.

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### XIII.—*Zoologico-Embryological Investigations.*

By M. Ussow\*.

“Developmental history is the true light-bearer for investigations upon organic bodies.”—VON BAER (*Ueber die Entwicklungsgeschichte der Thiere*, 1828, Bd. i. p. 231).

DURING my residence at Naples and Messina (1871–73) I turned my attention particularly to the exact investigation of the anatomy and developmental history of two extremely interesting classes of Invertebrate animals, namely the Cephalopoda and the Tunicata. In various species of the Cephalopoda I studied the structure of the female sexual organs, and the formation of the ova, and then, in four species, I traced the embryonal development from the fecundation of the ovum up to the complete development of the young.

In the various species of the Tunicata I endeavoured to investigate:—1, the anatomy, the minute structure, and the postembryonal process of metamorphosis of the central and peripheral nervous system; 2, the structure and in part also the mode of formation of the organs of sense; 3, the body-wall (the outer and inner mantle); 4, the circulatory system; and lastly, 5, the digestive apparatus, with all its glandular appendages.

As I am at present engaged in the detailed description of the by no means uninteresting facts that I observed, I think that a brief statement of the results obtained, such as I here propose to give, may not be without its use.

\* Translated by W. S. Dallas, F.L.S., from the ‘*Archiv für Naturgeschichte*,’ xl. (1874) p. 328.

## THE CEPHALOPODA.

No group of Invertebrate animals possesses so high an interest as the Cephalopoda with regard to the complication of their bodily structure. And, in fact, since the time of Cuvier\*, who, taking the exact data of comparative anatomy into consideration, first sharply defined them and separated them from the other classes of Mollusca, they have been placed by most zoologists† at the head of all Invertebrata. Some naturalists‡ who wished to see zoological classification founded upon embryological facts (at that time still little known and often misunderstood) thought that it might be possible to separate the Cephalopoda altogether from the Molluscan type, and to form a special type of them. Even before this peculiar opinion was expressed, a special kind (*evolutio radiata*§) of the so-called unilateral development was established for the Cephalopoda and some other Mollusca. Without denying the merit of these conceptions as to the systematic position of the Cephalopoda in the animal kingdom, which were valuable in their time, we may be allowed to put the question whether we are sufficiently acquainted with the most important modes of development of the organism of the Cephalopoda, and whether we are in a position, resting upon embryological facts, to state accurately the most sharply marked traits of their phylogenetic connexion, not with all the other types of the animal kingdom, but merely with the other classes of Mollusca, as with the Gasteropoda, and especially with the Pteropoda||. If we look closely into this last highly important scientific question, however, it appears that the positive facts now known to us regarding the developmental history of the Cephalopoda are far from sufficient, even approximately, to elucidate their genealogical relations. Notwithstanding the interesting results which were to be expected from the investigation of the developmental history of as many species of Cephalopoda as possible, we at present possess only three more

\* Mém. pour servir à l'hist. de l'Anat. des Mollusques, 1817, Mém. i.

† Lamarck, Hist. Nat. des Anim. sans Vert. 2<sup>m</sup>e édit. xi. p. 165; R. Leuckart, Ueber die Morphol. und die Verwandtschaftsverhältn. der wirbellosen Thiere, 1848; Huxley, Lectures on the Elem. of Comp. Anat. 1864, p. 85; Gegenbaur, Vergl. Anat. 2te Aufl. 1870, p. 78; Häckel, Gen. Morphol. Bd. ii. pp. cxv, 408 *et seq.*; Claus, Grundzüge der Zool. 2te Aufl. 1873, pp. 43, 44, 766 *et seq.*

‡ Vogt, Zool. Briefe, 1851, Bd. i. p. 298.

§ Von Baer, "Beitr. zur Kenntn. der niederen Thiere," Nova Acta &c. xiii. pl. ii. 1827; Kölliker, Entwicklungsgesch. der Cephalopoden, 1844, p. 175.

|| See Leuckart, *l. c.* p. 154; Gegenbaur, *l. c.* p. 473; Häckel, *l. c.* pp. civ, cxv; Keferstein, Klassen und Ordn. der Weichthiere, p. 1472.

or less detailed and accurate memoirs, which are chiefly devoted to the embryology of the Decapoda.

As early as the year 1841 Van Beneden published his investigations on *Sepiolo Rondeletii*\*. In 1844 Kölliker† enriched science with his well-known memoir on the development of various species of Decapod and Octopod Cephalopoda. Almost a quarter of a century later (1867) E. Metschnikoff‡ made known his investigations on *Sepiolo*; and last year (1873) Ray Lankester published a short communication§ on the development of *Loligo*. It seems scarcely necessary to enumerate the observations of Cuvier||, Dugès¶, and Delle Chiaje\*\* relating to this subject, as in most cases they contain very unsatisfactory and erroneous†† statements as to the embryonal process. As it is impossible for me in this short summary to submit the results obtained by Van Beneden and Kölliker to criticism, and as in the following report upon my investigations I indicate the most important errors of those *savants*, I shall devote a moment only to the most accurate of all these memoirs, that of E. Metschnikoff.

We may regard as one of the greatest merits of the above-mentioned important memoir, which only relates to one species of Cephalopod, the first description of two germ-lamellæ, and the more or less exact indication of the part they take in the subsequent formation of the different organs. Studying the development of *Sepiolo* and the mode of formation of the central nervous system, the intestinal canal, and the central organs of circulation solely in living embryos‡‡, without the aid of dissected preparations, must necessarily have caused Metschnikoff to miss many important facts, even with regard to the species investigated by him. As, moreover, from want of material, he was unable to trace the development of the ova, and especially their process of segmentation, this

\* "Rech. sur l'embryol. des Sépioles," in Mém. de l'Acad. de Brux. xiv.

† *Loc. cit.*

‡ History of the embryological development of *Sepiolo* (in Russian), 1867. See Arch. für Naturg. 1868, Bd. ii. p. 130, and Arch. des Sci. Phys. et Nat. xxx. (1867) p. 186. The following citations apply to the complete Russian work.

§ Ann. & Mag. Nat. Hist. 1873, no. 62, p. 81.

|| Ann. du Mus. 1832, i. p. 153.

¶ Ann. des Sci. Nat. viii. p. 107, 1837.

\*\* Memorie, 2nd edit. p. 39, 1829; Notom. degli anim. invertebr. 1841, i. p. 83, pl. xxix. figs. 4, 5.

†† Kölliker, *l. c.* pp. 110, 111.

‡‡ At least, in his memoir, Metschnikoff nowhere mentions that he studied sections, without which it is impossible to trace the formation of the intestino-fibrous layer, and to form a clear idea of the development of some organs.

distinguished observer unfortunately could neither subject the results obtained by Kölliker to a thorough testing, nor describe exactly the production of the second germ-lamella (parenchymatous lamella\*), nor, finally, ascertain the mode of formation of the intestino-glandular lamella. Undoubtedly Metschnikoff's observations on the mode of formation of the organs of sight and hearing, so superficially and inaccurately described by his predecessors, are of great value.

During my long residence in Naples and Messina I set myself, as one of my principal tasks, to investigate as completely as possible the development of several species of Cephalopoda, or, in other words, to subject all previous observations relating to this subject to a careful examination, in order, as far as possible, to enlarge our exceedingly defective knowledge of the embryology of these interesting animals. By the direct observation of living embryos in various stages, by the employment of the most serviceable method of the comparative examination of different sections, and, lastly, by the investigation of a formative vitellus (which would afterwards be converted into the so-called germinal spot and then into the embryo) with its parts firmly united, separated in a particular manner† from the nutritive vitellus, I have been able to follow step by step the whole developmental cycle of several forms of Cephalopoda. Some difficulties, which met me in this little-followed method of investigation, are fully compensated by a series of new and interesting facts, repeatedly confirmed by me, which I have succeeded in discovering and elucidating.

I have already succeeded in observing pretty accurately the development of the embryo in four species of Cephalopoda, namely three Decapods (*Sepia officinalis*, Linn., *Sepiolo Ron-*

\* *Loc. cit.* p. 67.

† In general terms this method is as follows:—First of all the fecundated ovum, with its capsule, is laid for from five to ten minutes in a weak solution of chromic acid, in which the capsule is removed. Then the ovum is placed for two or three minutes in fresh water, mixed with two or three drops of acetic acid. The chorion is removed in another portion of fresh water. The viscid, semifluid nutritive vitellus immediately flows out, while the germ, which is already somewhat hardened, falls to the bottom of the watch-glass. After the removal of the water the germ is carefully spread upon a glass slide, and, after being coloured with carmine, mounted in glycerine. The foundation of this whole operation is that the germ hardens more quickly than the peripheral layer of the nutritive vitellus; for only in this case will the former separate from all inversions of the latter. By its aid I have succeeded in separating the formative vitellus from the nutritive vitellus, the whole of which it surrounded, and in making a considerable collection of preparations of various stages of development of the Cephalopoda.

*deletii*, Leach, and *Loligo sagittata*, Lam.) and one Octopod (*Argonauta Argo*, Linn.).

For the more convenient exposition of the facts discovered by me, I shall divide this communication into two halves. 1. Anatomico-physiological data relating to the structure of the female generative organs and the mode of formation of the ova<sup>\*</sup>. 2. The results of my embryological investigations upon:—*a*, the process of segmentation; *b*, the formation of the blastoderm and the production of the germ-lamellæ (first period of development); and *c*, the original foundation of the organs up to the appearance of the typical Cephalopodal form<sup>†</sup> (second period of development). As the development of the above-mentioned Cephalopoda is *very concordant* in essential points, I shall not describe the development of the individual species, but the course of development in all the four species, in order to be as concise as possible.

### I. *The structure of the ovaries and the mode of formation of the ova of the Cephalopoda.*

In youngish female individuals of various species of Cephalopoda, the unpaired, rather large ovary, enclosed in the peritoneal sac, and situated in the lower, narrower part of the mantle, consists of numerous cæcal, ramifying tubules, which form its glandular parenchyma. In general the structure of the ovary is like that of the ovary in the Vertebrata, especially in Birds and Tortoises<sup>‡</sup>. There may be distinguished in it:—*a*, the very thin sheath (*theca folliculi*), consisting of fibrous connective tissue; *b*, the internal, *one-layered* epithelial membrane (*membrana granulosa*), which lines the inner surfaces of the above-mentioned tubular and vesicular ovarian spaces quite uniformly. In the first of the above-mentioned coats ramifies the thin artery (genital artery), which takes its origin from the lower part of the ventricle. The Graafian follicles are formed at different periods of the spawning (as may be

\* Besides the above-mentioned species, I have investigated the mode of formation of the ova and some stages of development in *Ommastrephes todarus*, *Rossia macrosoma*, and *Sepia biserialis*, Montf.

† I am at present occupied with the study of the last period of development of the Cephalopoda, namely the development of the embryo, which I am enabled to do by means of a great store of remarkably well-preserved material. The production of the organs is of especial importance in comparative embryology; and to this I have particularly directed my attention.

‡ As made known by Gegenbaur's investigations (Arch. für Anat. &c. 1861, p. 491); Hiss, Erste Anlage der Wirbelth. p. 19 *et seq.* pl. ii.; and Waldeier, Der Eierstock, pp. 48 & 69, pl. iv.

judged from the greater or less maturity of the ova contained in them), and continuously (as quite young ova may always be found in them), and, indeed, as diverticula of the epithelial membrane of the ovary. The primitive ovicell, or the future so-called *formative vitellus* of the composite ovum, is nothing but a more developed cell of the epithelial coat of the ovary, which constantly growing cell, with the epithelium surrounding it, separates more and more from the ovarian spaces, and finally remains united to the central mass of the ovary only by a longer or shorter peduncle. In the further development of the ovary the racemose or lobate form of that organ is due to the number of such Graafian follicles attached to peduncles and the number of young immature ova enclosed in them. The development of the ova always commences in the central part of the ovary, and increases pretty regularly towards its periphery, where the Graafian follicles and the ova (1-6 millims. in diameter) attain their full development. The relation to the ovary of the entrance into the *unpaired* (*Sepia*, *Loligo*, *Sepiolo*, *Rossia*) or more rarely *paired* (*Ommastrephes*, *Argonauta*) oviduct (paired oviducts are always equally developed) is always the same in all the Cephalopoda investigated by me; and the mode of escape of the mature ova first into the ventral cavity, and then their gradual passage into the oviducts, which contract peristaltically (*Argonauta*\*), and are sometimes repeatedly twisted and bent, remind one of the similar processes in some Carnivora (*Lutra*). The naked ovicell† (*gymnocyta*), with the nucleus (= germinal vesicle) and the nucleolus (= germinal spot), grows simultaneously with the Graafian follicle, so that at first both increase in size pretty uniformly. But soon the growth of the Graafian follicle advances more rapidly by multiplication (longitudinal division) of the cells of the *membrana granulosa*, which forms, on the inner surface, a series of longitudinal and transverse folds penetrating into the vesicle‡. The blood-vessels lying on the surface of the epithelial envelope penetrate into the interspaces of the above-mentioned folds, by which means both the considerably en-

\* The oviducts of this animal, taken out of the body and laid in water, continue to contract for a long time, by which means it becomes possible to obtain perfectly fresh ova belonging to different stages of segmentation. Ova procured in this manner, or even taken out of perfectly mature Graafian follicles, generally undergo further development.

† In *Loligo* and *Argonauta* at this time 0.008 millim. in diameter.

‡ In *Sepia* these folds are double, but only the inner ones form the diverticula described below; the outer ones, on the contrary, form a uniformly diffused layer between the inner ones and the thin *theca folliculi*. Between the two kinds of folds the blood-vessels ramify, and new ovicells originate.



larged cells of the *granulosa* and the ovicell, which has been pushed by the folds to the superior pole of the originally round Graafian follicle, are abundantly provided with nourishment. At this time—that is to say, in the period of the “foldings” (Kölliker)—the cells of the epithelial membrane begin to secrete the fluid, fatty, transparent *nutritive vitellus*. Consequently the fold-formation of the *granulosa* only serves for the temporary enlargement of the inner surface of the Graafian follicle, which secretes the nutritive vitellus. In this state each Graafian follicle may be regarded as an independent gland. Of the vitelline membrane (*chorion*\*) there is at this time not the slightest trace; so that the description of the nature of the so-called “folding-process” as given by other observers† proves to be very superficial and erroneous (of which I have fully convinced myself). The chorion is formed subsequently, after the nutritive vitellus is completely secreted and the ovum has attained the limit of its perfect development. The chorion, which is at first fluid and viscous, is, indeed, nothing but a secreted product of the *granulosa* of the Graafian follicle, which may be proved by the fact, among others, that at the commencement of its formation, especially at the superior somewhat acuminated pole, its composition of several thin superimposed layers may be distinctly observed. At the same time there is formed at the above-mentioned thickened part of the chorion, in a manner which, I must confess, is still obscure to me‡, its tubular micropyle, more or less widened and funnel-shaped in its upper part. This I have found in all the above-mentioned species and groups of the Cephalopoda.

At a very early stage of development the Graafian follicle gradually changes its spherical form, and acquires the shape of an egg pointed at the upper free pole. The enclosed ovum follows in its form that of the Graafian follicle. The primitive ovicell with the nucleus (= germinal vesicle) moves, as already stated, to the upper pole of the Graafian follicle, which is now pretty acute (*Loligo*, *Sepiola*, *Argonauta*), and the *granulosa* of which has scarcely any folds and appears quite smooth at this part. Here, therefore, is the finely granular protoplasm of the primitive ovicell; and by this means

\* Kölliker (*l. c.* p. 15) and other observers (Klassen und Ordn. Bd. ii. p. 1405) quite erroneously take the external pluristratified capsule of the Cephalopod ovum for the chorion, and the true chorion (formed within the Graafian follicle and always furnished with a micropyle) for the vitelline membrane.

† Kölliker, *l. c.* pp. 2-13; Brandt, *Mediz. Zool.* Bd. ii. p. 300, Taf. xxxii. fig. 27; Owen, *Memoir on the Pearly Nautilus*, p. 42.

‡ Where the micropyle is situated there are no folds (“free space,” Kölliker), and the *membrana granulosa* there forms a thin layer.

it acquires the form of a very flat, conical disk, in the thickened central part of which the germinal vesicle is situated. The above-described folds of the *granulosa* are gradually effaced as the ovum enlarges, and finally disappear altogether, so that at last it becomes perfectly smooth both within and without. The perfectly mature ovum by its own weight ruptures the very thin part of the envelope (the so-called *stigma*) at the upper pole, and is fecundated\* at the moment when it falls into the ventral cavity (*Argonauta*).

For the elucidation of the above-mentioned question as to the continual development of the ova of Cephalopoda commencing at different times, I may add that I have succeeded in observing that, at the time of the strongest development of the folds, new ova are developed in the Graafian follicle from any of the cells of the epithelial membrane. A part of the inner surface of the fold gradually covers the newly formed ovum, which during its enlargement protrudes at the surface, becomes constricted off from the Graafian follicle, and finally remains united to the *theca folliculi* only by means of a short peduncle. Thus, in consequence of more or less copious nutrition, the cells of the *granulosa* of a Graafian follicle may in a short lapse of time bring the primitive ovicell to full development, and secrete the whole mass of the nutritive vitellus and finally the transparent chorion †. This is in its main features the mode of formation of the Graafian follicle and the ova of the Cephalopoda. Of its correctness I am perfectly convinced by an attentive and frequently repeated study of the process. As regards the original development of the female sexual organs of the Cephalopoda, I could not trace it, as it appears to be correct that the mature embryo, after its escape from the egg, and even the young animal from one to three days old, possess no trace of these organs ‡; but at the end of three days, during which it has used up the whole of the outer and a part of the inner nutritive vitellus, the animal dies, and consequently deprives us of all possibility of investigating the development of the sexual organs and the part taken by the germ-lamellæ in their construction. With

\* I can assert this positively with regard to the fecundation of *Argonauta*. Although in all the other species, also, I found perfectly mature spermatozoa in the ovaries, the segmentation takes place always outside the body, which would indicate a pause between the fecundation and the commencement of development.

† In *Argonauta* also the longer or shorter filiform process.

‡ The same results were obtained also by Kölliker (*l. c.* p. 110) and Metschnikoff (*l. c.* p. 65). At the end of the third period I have observed below the ventricle in *Sepia* and *Loligo* an aggregation of cells, from which it is possible the sexual organs are developed.

regard to the spawning-time\*, the number of mature ova and other details in the formation and development of the Graafian follicle and other accessory glandular organs (albumen- or nidimental glands of the Cephalopoda), I reserve their description for a complete memoir on the animals named.

## II. *Segmentation of the ova of the Cephalopoda, and formation of the one-layered germ (blastoderm).*

The whole of the mature ova which fall from the Graafian follicles into the ventral cavity are, apparently, without exception, fecundated†. The mature Cephalopod ovum, which, in form, is very like a hen's egg, contains the following parts:—1, a very small mass of the so-called formative vitellus, which, as we have seen, represents the finely granular protoplasm of the primitive ovicell with its nucleus (germinal vesicle); 2, a greater or less quantity of the rather viscous, fatty nutritive vitellus; 3, a perfectly transparent albuminous substance which occupies the space between the vitellus and, 4, the many-layered vitelline membrane (chorion) with its tubuliform micropyle; and, lastly, 5, a more or less thick, many-layered egg-capsule which sometimes runs out into an elastic thread, serving to attach the ova to various objects under water (*Argonauta* ‡, *Sepia*), and sometimes forms a longer or shorter sac containing 10–100 or more ova (*Sepiola*, *Loligo*).

At the moment of fecundation the germinal vesicle does not disappear; and the segmentation of the finely granular protoplasm of the primitive ovicell, or the so-called formative vitellus, which may easily be distinguished by its somewhat dark coloration from the nutritive vitellus, always commences with the cleavage of the germinal vesicle. In *Argonauta* the process of segmentation takes place chiefly in the body of the mother, and, indeed, during the movement of the ova in the tortuous oviducts§; whilst in all the other Cephalopoda observed by me the segmentation always seems to

\* In *Argonauta* the spawning-time lasts from May to August, in *Loligo*, *Sepiola*, and *Ommastrephes* from March to June; but I obtained mature ova of *Sepia* in Naples almost all the year round, except in August.

† Among the thousands of Cephalopod ova which I have examined, scarcely any unfecundated ova occurred.

‡ In *Argonauta* to the apex of the shell, so that the female, which is seated in the shell, covers with her hinder parts the racemose groups of eggs placed within the spire.

§ I observed the first stage of segmentation in ova which were taken out of the entrance to the oviducts, whilst in those near the orifice, eight, or even sixteen, segments are already present.

commence outside the body of the parent. The segmentation of the formative vitellus of the Cephalopoda greatly reminds us, as regards its form, of the segmentation of the eggs of birds\* and Chelonia†. In all the four species of Cephalopoda investigated by me it is *irregular*. The division of the protoplasm of the formative vitellus commences in its thickened central part, and spreads towards the attenuated peripheral part, which uniformly surrounds the *whole surface* of the nutritive vitellus. The latter takes no part in the segmentation process ("partial segmentation"). One of the chief causes of the segmentation of the formative vitellus seems to be the great mobility of its protoplasm, and the changes of position of its heaviest parts, the darkest-coloured granules. The segmentation always begins in the vicinity of the nuclei of the segmentation-cells (spheres of segmentation) or segments; and the close of the complete cleavage (by longitudinal or afterwards transverse division) coincides with the complete separation of the nuclei. At first all the cleavages appear only at the surface of the formative vitellus, but then gradually penetrate by deepening to the lowest layers of the protoplasm.

The original or first furrow‡, which divides the whole formative vitellus into two equal segments lying side by side, is soon (in about two hours) intersected at right angles by a second furrow. As the result of this division *four* equal segments, enclosing four clear nuclei, are produced (the nucleoli are entirely deficient). In the central point there is produced a very inconsiderable clear interspace, which in the sequel soon disappears. The subsequent cleavages of the formative vitellus are irregular; from four segments there are formed (in four hours), first *six*, and then *eight* equal segments. In the period between the formation of the six and of the eight segments, there are produced at the centre of union of the furrows, in the earliest moments of the appearance of the two narrowest segments, by constriction of the apices of these, *two* primitive cells or spheres of segmentation (approximately between the third and fourth hour of the process of segmentation). From the two of the eight segments which are situated

\* Coste, Hist. part. et gén. des corps organisés, p. 287, pl. ii.

† Agassiz, Contrib. to the Nat. Hist. of the United States, ii.

‡ In *Loligo*, *Sepiolo*, and *Argonauta* this furrow appears directly beneath the micropyle, in the centre of the formative vitellus; in *Sepiolo* sometimes a little to one side, which I regard as an abnormal phenomenon, as also that I once in *Sepiolo* found the segmentation on the lower obtuse pole of the ovum. The hours mentioned in the following description of the process of segmentation relate to *Sepiolo* and *Loligo*.

opposite the narrow segments just mentioned, *two* very large segmentation-spheres are now separated by constriction (during the fourth hour); and these place themselves directly opposite to the two primitive spheres. In this way, in about four hours from the commencement of segmentation, there are produced *eight* segments and *four* spheres of segmentation. From these four, and ten subsequently produced spheres of segmentation, originates, by means of further spontaneous division (longitudinal division), the central part of the germinal disk.

In the subsequent stages we observe the following:—1, a rapid multiplication of the central segmentation-spheres, *a*, by spontaneous longitudinal division, and, *b*, by the rather rapidly advancing constriction of the apices of the segments; and, 2, a multiplication of the segments by their slower longitudinal division. In this way, about the seventh hour of the process of segmentation, there are produced 10–12 radiating segments, whilst there are still only four central segmentation-spheres; in the eleventh hour there are eighteen segments and at the same time fourteen segmentation-spheres (eight by division of the four above mentioned, and six newly constricted apices of the two longitudinal and four lateral segments). In the next (twelfth) hour a sphere is separated by constriction, by means of the so-called meridional segmentation, from each segment; all these spheres collect around those previously formed, and consequently at this stage the number of segments amounts to eighteen, and that of the segmentation-spheres to thirty-two. In the next stage of segmentation the number of segments increases to thirty-two, which surround the germinal disk. But the latter now consists of 108–110 cells, larger towards the periphery, smaller in the centre, which have multiplied in this manner by increased division. The number of nuclei of the segmentation-spheres and segments likewise increases, a nucleus being contained in every sphere and in every segment. Both kinds of cells show no trace of a membrane; their finely granular protoplasm becomes constantly darker, and is transformed from a transparent to a translucent substance.

During the whole course of the process of segmentation the outwardly directed surfaces of all the segments, and especially of all the segmentation-spheres, are much raised, the highest being placed in the centre of the formative vitellus. At the close of the whole process, in the last stages, their convexities are far less observable; and finally the tubercular surface of the formative vitellus becomes quite smooth. As the final result of all these divisions, the *one-layered* germinal disk

("germinal spot," Kölliker) is produced. In this, as regards the size and form of its constituent cells, and also their distribution, the following two divisions may be distinguished:—1, the centre of the germinal disk, which presents the form of a convex circle, and has been formed by the multiplication of the high cylindrical primitive segmentation-cells (see the stage of eight segments); and, 2, the originally very narrow, but gradually widening *ring*, which immediately follows the above-mentioned disk: the somewhat broader, but flatter, pentagonal or hexagonal cells of which have been formed chiefly from the apices of the segments constricted off by the meridional furrow (see the stage of the meridional furrow).

Directly united with this ring is the *inferior part*, which extends to the inferior pole of the nutritive vitellus and encloses the latter. This part consists of the apices of segments\* slowly advancing in their division, and of the segments themselves, which are here (at the inferior pole) not sharply separated, but often even mutually coalescent. Their number remains as before (thirty-two). Their finely granular protoplasm covers with a very thin layer the whole mass of the nutritive vitellus, which in this way is enclosed as in an envelope from the very commencement of the segmentation in the so-called formative vitellus, or, to be more exact, in the protoplasm of the primitive ovi-cell, lying uniformly on its surface except at the superior pole, where it is perceptibly thickened. The so-called disappearance of the segments in reality never occurs. Earlier or later they all divide, as we shall see, and furnish a certain number of the cells forming the one-layered blastoderm†.

From the actual course of the process of segmentation of the Cephalopod ovum here described, and which I have traced in all its details, we may easily convince ourselves of the inaccuracy of the opinion expressed by Kölliker upon this question. And, in fact, I have perfectly convinced myself, by a series of frequently repeated investigations, that he observed stages in the development of the ova of *Sepia* which were quite independent of each other, and that his researches were carried on under abnormal conditions, in which the union of the segments and the segmentation-apices was already much injured. Thus, for example, Kölliker indicates in the centre of union of the segmentation-spheres indefinite and irregular

\* In the last stage of segmentation the apex of every segment divides into groups of cells, which arrange themselves in parallel rows on the equator.

† In *Sepia* the blastoderm closes at the inferior pole of the nutritive vitellus only in the second period, as, indeed, Kölliker has described.

interspaces, such as I have seen in no species investigated by me. The mode of formation of the embryonal cells is also, as follows from the preceding statements, quite erroneously described by Kölliker.

### III. *The formation of the Germ-lamellæ.*

The above-mentioned concluding stage of the process of segmentation (*i. e.* the appearance of the germinal disk, or the one-layered germ, consisting of the *upper germ-lamella*, which appears at the upper pointed part of the nutritive vitellus and covers a twelfth part of it) occurs in most of the Cephalopoda observed by me on the second day after the commencement of development\*. The important moment of the appearance of the second germ-lamella falls in the beginning of the third day (*Sepia, Loligo, Ommastrephes*). The original separation of the second germ-lamella takes place in the following manner:—In the *middle part* of the above-mentioned one-layered ring, situated immediately below the centre of the germ (now very like the *area opaca*), the cells, which are continually undergoing further division in a longitudinal direction, begin also to divide gradually in a *transverse direction*, the division commencing at the lower periphery and advancing towards the centre. The nucleus of each cell of the one-layered upper germ-lamella becomes elongated; and at the same time the protoplasm is also elongated, like a drop, downwards; and then a new cell is constricted off from the mother cell. As the result of this transverse division a *second germ-lamella* is produced, at first only in the median ring of the germinal disk, but afterwards also in the central part and in the segment-part. At the spots where it has been formed, the germinal disk soon becomes quite opaque, and appears dull white by direct light.

In the following days (about to the fourth or fifth) the above-described process of growth is continued, and now in all parts of the germinal disk, by which means, 1, the diameter of its still one-layered central part increases considerably; 2, the middle two- or more-layered thick part (*area opaca*) spreads more and more towards the inferior pole; and, 3, the region of the segments dividing up into cell-groups which follows directly on the ring now commences at the equator of the vitellus (and therefore much lower than before). The thick-

\* In *Argonauta* the germinal disk is formed as early as the seventh or eighth hour from the commencement of segmentation.

ened inner layer of the *area opaca*, which consists of rounded, scattered, spontaneously dividing cells\* (of the second germ-lamella), forms, at the boundary of the central part of the germinal disk, a wall which penetrates more or less into the nutritive vitellus. In consequence of this pressure, the nutritive vitellus on its part penetrates into the slightly rising central part of the germinal disk (like the "Dotterpfropfe" of the frog's egg). At the same time a very narrow *second ring* is formed from the cells separated by constriction from the segments; this lies between the first ring and the segments. On the sixth and seventh days this new ring exactly surrounds the equator of the vitellus. Its four- or five-angled cells, which are rather large, lie in consecutive series. Indeed, in general, all the cells, both of the inner and outer germ-lamella, arrange themselves in such consecutive series; the latter, during their division (constriction), when they are for a short time free, move upon the surface of the nutritive vitellus by means of their contractile protoplasm and longer or shorter pseudopodia.

At the end of the seventh day the cells of the central conical part of the upper germ-lamella multiply very rapidly by longitudinal division (*Sepiolo*, *Loligo*, *Argonauta*). By this means is produced a thickening, which, however, by no means occupies the whole central part of the germinal disk, but only forms at its margin an *oval fold*, which, spreading in the polar direction, begins gradually to conceal the central part. Simultaneously with the formation of this fold, the part of the germinal disk circumscribed by the fold sinks a little and forms a furrow broader and deeper in the middle, having the shape of an extended rhomboid. In the rhomboid the germinal disk consists of a single layer of cells of the upper germ-lamella. But beneath the oval fold the cell-layer of the second germ-lamella which is there thickened begins to double itself by transverse division, and thus forms two layers—the upper the *dermo-muscular layer*, and the lower the *intestino-fibrous layer*. These two layers may be most clearly observed at the boundary of the former *area opaca* and the central part of the germinal disk, and, indeed, on the future ventral surface of the embryo, whilst at first they gradually coalesce towards both the equator and the pole, so as not to be distinguishable. The further splitting of the second germ-lamella into two superposed layers takes place

\* The cells divide both in a longitudinal and transverse direction, by which means their layer becomes thicker and broader towards the obtuse pole.



at the time when the nutritive vitellus is entirely surrounded\* at the inferior pole by the cells of the upper germ-lamella formed by terminal division of the segments, and by the upper layer of elongated fusiform cells of the second germ-lamella.

On the seventh and eighth days the germ enclosing the nutritive vitellus gradually changes its form from oval to perfectly spherical. In *Loligo*, *Sepiola*, and *Ommastrephes* the surfaces of most of the cells of the upper germ-lamella (spherical embryo) (those on the part where the eye-ovals will be formed and some others excepted) become covered with cilia, which, in the species above enumerated, cause the rotation of the embryo by their continual movement. In *Sepia* and *Argonauta* the embryo does not rotate, either in this or the following stage of development. The period of formation of the blastoderm (including the process of segmentation) lasts from four (*Argonauta*) to nine (*Loligo*, *Sepiola*) and more days (? *Sepia*).

Thus at the commencement of the rotation, with which the second period of development (that of the production of the organs) begins, the germ covers the whole of the nutritive vitellus, and consists of two germ-lamellæ here and there composed of several layers, namely:—1. The blastoderm or upper germ-lamella (*Hornblatt*). The thickness of this lamella, which is still one-layered, increases somewhat as we approach the upper pole of the nutritive vitellus†, and, indeed, at the point where the oval fold covering the rhomboidal part of the germ, situated on the dorsal surface of the embryo, is formed. The rhomboidal centre of the germ, which was at first round, and the oval, broader or narrower annular fold originate from the considerably grown central part of the germinal disk, situated at the acute pole and bordering upon the so-called *area opaca*; but this part itself has originated from the fourteen primitive segmentation-spheres, which rapidly increased in number and appeared at different times. The middle portion of the germ, which now covers nearly half the surface of the nutritive vitellus (from the margin of the above-mentioned fold to the equator) and attains its greatest breadth upon the dorsal surface, represents the considerably widened middle ring of the germinal disk, which originated from the multiplication of the cells chiefly constricted off from the segments by the meridional furrow. Here

\* In *Loligo*, *Sepiola*, and *Argonauta*; in *Sepia* the blastoderm, as already remarked, only closes in the second period of development.

† By transverse division of its cells, which become cylindrical and generally contain two sharply defined nuclei.

also the first germ-lamella is thickened (especially at the sides and on the dorsal surface) by its cells dividing rapidly in the longitudinal direction, by which means they become higher and cylindrical.

This part is followed immediately by the rather narrow girdle-like part, originating from the segmentation-spheres uniformly separated by constriction from all the thirty-two segments, which occupies the equator of the vitellus, and is bounded above by the middle portion (the future trunk of the animal), and below by the blastoderm (rudiment of the yelk-sac), which is everywhere uniformly thin, two-layered, and closed at the inferior pole. In the above-mentioned peripheral girdle-like portion of the spherical germ the cells are broad, but at the same time flat; so that this part is as thin as the rudiment of the yelk-sac. At the end of the first period all the cells of the upper germ-lamella are distinguished only by their height and breadth; as regards their form there is nothing peculiar to certain parts of this germ-lamella. There are cells with three or four angles, and with them others with five, six, seven, or even eight angles.

2. The second or middle germ-lamella, which attains its greatest thickness at the oval fold, and splits into two layers, the dermo-muscular layer and the intestino-fibrous layer. With the development of the germ this cleavage of the middle germ-lamella increases both by the transverse division of its cells and also by the spreading of the two layers, which takes place in the direction from the rhomboidal centre towards the yelk-sac.

The two layers of the second germ-lamella show the following characters:—*a.* The dermo-muscular layer (*Hautmuskel-schicht*) thickens somewhat in the central part of the blastoderm and in the girdle-like ring situated on the equator of the vitellus; by the continued gradual division of the cells of the blastoderm (see the commencement of the formation of the second germ-lamella), and by the independent longitudinal division of its cells, this layer grows pretty rapidly beneath the upper germ-lamella and becomes closed at the inferior pole of the nutritive vitellus. *b.* The intestino-fibrous layer (*Darm-faserschicht*), as the development of the germ goes on, occurs not only on the ventral surface (below the oval annular fold of the rhomboidal centre), but its rather loose cell-series, lying immediately upon the nutritive vitellus, also increase towards the dorsal surface in the middle part of the germ. Various sections from earlier stages (*e. g.* of the tenth day) show that the cells of the intestino-fibrous layer accumulate most on the sides of the longitudinal axis of the germ, namely where the

alimentary apparatus will afterwards be developed. Near the boundary between the middle and the girdle-like parts this layer entirely ceases, and in the girdle-like part (region of the formation of the arms) and further to the pole of the nutritive vitellus and round the latter we only meet with the cells of the dermo-muscular layer, as has already been stated. Consequently the lower or intestino-fibrous layer of the second germ-lamella, as may easily be seen, originates by transverse division of the originally one-layered second germ-lamella, and therefore in the same way as the latter lamella itself from the cells of the one-layered blastoderm or the upper germ-lamella. The cells of both layers of the middle germ-lamella are always rather smaller, but are more numerous than those of the upper lamella. In form they are generally oval, not unfrequently extended (in the wall of the yolk-sac); their protoplasm is dark, fatty; and the nucleus (or often two) enclosed in each cell can scarcely be detected without reagents. None of the cells of either the second or the upper germ-lamella contain any trace of membranes.

It is not without a purpose that I have dwelt so long on the mode of formation, the individuality, and the distribution of the first two germ-lamellæ, seeing that the only extant memoir treating of this subject (namely that of E. Metschnikoff\*) is not quite satisfactory. In the first place, this naturalist has not recognized the second or inferior lamella ("parenchymatöse") as the middle one; and secondly, he has not referred to its cleavage into the two layers above described, which play so important a part in the formation of the embryonal organism. I regard it as almost unnecessary to add that my wearisome investigations of the development of four different species of Cephalopoda completely contradict the opinion put forward by Kölliker †, according to which both the germ-lamellæ are denied to the Cephalopoda.

[To be continued.]

XIV.—On the Genus *Rossella* (a *Hexactinellid* Sponge), with the Descriptions of three Species. By H. J. CARTER, F.R.S. &c.

[Plate X.]

IN 1872 I published some figures of two forms of sponge-spicule which were found abundantly adhering to fragments of a *Tethya* (*T. antarctica*, C.) that had been dredged up from

\* *Loc. cit.* p. 19.

† *Loc. cit.* p. 167.

the bottom of the Antarctic Ocean by Sir J. Ross, in 300 and 206 fathoms and in  $74\frac{1}{2}^{\circ}$  and  $77\frac{1}{2}^{\circ}$  south latitude respectively, which, with other deep-sea specimens obtained at the same time, had been handed over to the British Museum by the Admiralty.

For the sponge from which these spicules were supposed to have been derived I proposed the generic name of "*Rossella*," and for the species "*R. antarctica*" ('Annals,' 1872, vol. ix. p. 414, pl. xxi.). One form of the spicules was regarded as podal or anchoring, and the other as belonging more directly to the body of the sponge.

In the same year another specimen of this genus was obtained by the British Museum from Cebu, one of the Philippine Islands, through Dr. A. B. Meyer ('Annals,' 1872, vol. x. p. 113), and named by Dr. Gray "*Rossella philippensis*" (*ib.* p. 137).

In March 1873 four more specimens of the same sponge were obtained by the British Museum from the same neighbourhood, again through Dr. Meyer; and from their having a different aspect, Dr. Gray proposed for these the name of "*Psetalia globulosa*," stating that they would be described by myself more particularly thereafter ('Annals,' 1873, vol. xi. p. 234).

Subsequently (that is, in the month of June following) I received from Prof. Wyville Thomson the specimen of *R. velata* from which his figure in 'The Depths of the Sea' (p. 418) was taken.

And in the month of March 1874 a glass jar was discovered in the British Museum, containing two small specimens of the veritable *Rossella antarctica*, dredged up by Sir J. Ross in 300 fathoms,  $74\frac{1}{2}^{\circ}$  south latitude, no doubt at the same time that the fragments of the *Tethya antarctica* and the spicules above mentioned were obtained.

Thus provided, I have been able to compare all these specimens, and find that they all belong to one genus, viz. *Rossella*, but that the Antarctic, Philippine, and Atlantic deep-sea ones possess peculiarities entitling them to be considered three different species. These peculiarities will appear in the following descriptions respectively, beginning with that of

*Rossella antarctica*, Carter. Pl. X. fig. 4.

General form sac-like, compressed (? *nat.*), with the upper end truncated and open, and the lower one conical and closed (fig. 4, *a*). Aperture elliptical, more or less elongate, corre-

sponding with the long transverse diameter of the body (fig. 5, *a*), leading into a cavity of much the same shape as that of the sponge externally (fig. 4, *ee*). Sessile or fixed by anchoring-spicules. Colour grey. External surface uniformly cribellate and monticular, covered by a thin layer of spicular latticework, and surmounted by three forms of projecting spicules situated respectively on the truncate end, on the body, and on the conical end, as will be more particularly described hereafter. Internal surface, or that of the cavity, uniformly smooth, interrupted by depressions or pits increasing in size towards the lower part. Body or wall constructed of a dense interlacement of large and small spicules, rendered more solid and areolar by the addition of sarcode charged with the minute spicules of the species, and accompanied throughout by the ramifications of the excretory canal-system. Layer of latticework formed of minute, sexradiate, spiniferous spicules, whose horizontal arms, spreading out at right angles to and overlapping each other, form a quadrangular retiform structure held together by the dermal sarcode. Pores situated in the sarcode filling the quadrangular spaces of the latticework. Vents opening into the pit-like depressions on the surface of the cavity. Spicules of three kinds, viz. appendicular, structural, and flesh-spicules. A. Appendicular, of three forms, corresponding with their respective localities:—1. That constituting an erect beard, about a quarter of an inch long, situated round the aperture (fig. 4, *c*), stout, linear, smooth, nearly straight, fusiform, acerate, finely pointed at each end, averaging 10-12ths by 8-1800ths of an inch in its greatest diameters. 2. Anchoring-spicule, which issues from the surface of the body generally, beginning very scantily above in little groups here and there, which increase in number, size, and length towards the lower or conical end, where they attain their maximum size and density (fig. 4, *dd*): stout, smooth, linear, commencing in a finely attenuated end which is fixed in the sarcode of the body, and gradually passing into a thick shaft which is abruptly terminated at the free end by *four* opposite, stout, recurved spines or hooks (fig. 3); average largest size 3 to 4 inches by 5-1800ths of an inch in its greatest diameters, hooks 30 by 5-1800ths of an inch. 3. Crucially headed or veil-spicules, projecting chiefly from the monticules, over every part of the external surface but the aperture, consisting of a shaft whose pointed or inner end is fixed in the sarcode of the body, and whose free or outer one is terminated by four long arms spread out horizontally so as to intercross with those of its neighbours, and thus form a general veil-like covering separated from the body by the length of the shafts between

the body and their heads respectively (fig. 4, *b b*); shaft smooth, or only microtuberculate over the imbedded end; arms more or less flexuous, fine-pointed, parting from the head of the shaft at different angles, covered almost throughout with minute spines, closely approximated, amongst which, here and there, is a much larger spine, curved and inclined outwards or *from* the head of the shaft; average largest size 2 to 3-12ths by 5-1800ths of an inch in the greatest diameters, both for the arms and shaft respectively, the former for the most part longer than the latter. B. Structural spicules (that is, of the body or wall) of three forms, viz.:—4. Nail-like or crucially headed, much like that last described, but with the shaft shorter and the arms longer; the former vertically placed in the wall and the latter spread out horizontally over its external surface, so as to support the lattice-like layer of minute sexradiate spicules imbedded in the dermal sarcode immediately above and the shafts of the veil-spicules beyond; arms more or less curved inwards, so as to render the head of the spicule prominent or monticular, thus characterizing the surface by a number of conical eminences linked together by radiating arms. 5. A long linear spicule, nearly straight, fusiform, often presenting in the middle two or four tubercles corresponding to the ends of the crucial branches of the sexradiate central canal, terminating in spined and more or less inflated extremities, but otherwise smooth; average largest size 3-12ths by 2-1800ths of an inch in its greatest diameters; situated on the inner side of the wall chiefly, where it forms, together with minute sexradiates and flesh-spicules, the surface of the concavity. 6. Sexradiates, of different sizes, with arms of equal length, spined and pointed, chiefly composing the lattice-like structure, which, in the way above stated, covers the whole of the dermal surface with quadrangular interstices from 1-300th to 1-150th of an inch in diameter. C. Flesh-spicules of four rosette-forms, chiefly situated in the surface-layer of the *cavity*:—7. Sexradiate *rosette* with smooth pointed arms of equal length ('Annals,' 1873, vol. xii. pl. xiii. fig. 1). 8. Sexradiate rosette with short arms and double rays (*ib.* fig. 3). 9. Very minute sexradiate rosette with numerous straight capitate rays (Pl. X. fig. 7, *b*). 10. Sexradiate rosette with thick, sparsely spined arms (fig. 6, *a*), whose inflated ends support four or more indistinctly capitate rays (fig. 6, *b c*): rays microspined, thick at first, then becoming finely attenuated and terminating in a hardly perceptible capitate inflation (fig. 6, *d*); rays at first straight and parallel like the prongs of a dinner-fork, becoming more or less divergent towards their extremities (fig. 6); average largest size of the

arm  $3\frac{1}{2}$  by 1-6000th of an inch in its greatest diameters, that of the inflation and rays about  $7\frac{1}{2}$ -6000ths of an inch long (N.B. This is the characteristic rosette of the species). Size of entire specimen  $1\frac{3}{4}$  inch long by 10-12ths of an inch broad, and  $7\frac{1}{2}$ -12ths of an inch thick; aperture about  $7\frac{1}{2}$ -12ths of an inch long by 2-12ths wide; margin thick, round; depth of cavity  $1\frac{1}{2}$  inch; thickness of wall about 3-12ths of an inch.

*Hab.* Ocean-bed.

*Loc.* Antarctic Sea in 300 fathoms, and lat.  $74\frac{1}{2}^{\circ}$  S.

*Obs.* The hexactinellid character of the spicules of this sponge, together with the free termination of the "anchoring-spicule" in four stout spines or hooks recurved and opposite (Pl. X. fig. 3), characterizes the genus, viz. that of "*Rossella*;" while the erect beard of spicules round the aperture (fig. 4, c), and the peculiar form of the flesh-spicule (no. 10, fig. 6), which is by far the most abundant, determine the species, viz. *R. antarctica*. There is no rosette-like flesh-spicule that I have yet seen wherein the arms are so distinctly, although so sparsely, spined, and the rays so parallel, so little divergent at their extremities, and so little inflated or capitate. (Altogether, the slightly inflated end of the arm, and the microspined rays which it supports, are a miniature form of the head of the scopiform spicule of *Aphrocallistes beatrix*, 'Annals,' 1873, vol. xii. pl. xv. fig. 2.) It is not improbable that there are other forms of the rosette flesh-spicule present in this species besides those described; but if so, I have not seen them, and if there are any, they are of no consequence in a specific point of view after no. 10.

*R. antarctica* further differs from the two following species, so far as my observations extend, in not possessing the other flesh-spicules or forms of rosette which are common to both *R. velata* and *R. philippensis*; while it agrees with *R. velata* in the more or less developed state of all the arms of the sex-radiate spicule of the latticework layer on the surface, thus differing from *R. philippensis*, in which for the most part the four horizontal arms alone are present.

I have described the monticular and latticework layer of the surface in a much more perfect state than it exists in the specimens of *R. antarctica* to which I have alluded, where, from rough usage at some time or other, as in some of the specimens of *R. philippensis*, a great part of the latticework layer has been abraded, thus rendering the cribellate and monticular surface below more evident; but still enough of the former remains here and there to show what the specimen was in its entirety.

From the presence of several minute specimens of this

sponge growing upon little bundles of anchoring-spicules projecting from the surface, it seems probable, if these do not originate in ova which have respectively fixed themselves there for development, that they arise from pullulation or budding.

In my description of *R. antarctica* the spicules are numbered 1 to 10 inclusively, to avoid unnecessary repetition in the following species, which will also be described generally with reference to what has already been stated.

Lastly, by comparing my representation of *R. antarctica* (Pl. X. fig. 4), and its previously delineated spicules (*l. c.*), with Schmidt's representations of his "*Holtenia Pourtalesii*" ('Atlantisch. Spongienfaun.' Taf. i. figs. 1-6), the probability of the latter being a species of *Rossella*, as I have heretofore stated, will appear still greater.

*Rossella philippensis*, Gray. Pl. X. fig. 1.

General form globular (fig. 2), ovate, or cup-shaped (fig. 1), thus perhaps varying in accordance with the age, development, and wearing of the specimen; presenting a flattened summit in which there is an aperture (fig. 1, *d*), and a conical base which is closed, but rendered irregular by mammiform prolongations of the body, out of each of which issues a hair-like lock of long anchoring-spicules (fig. 1, *c c c c*); mammiform prolongations &c. increasing in size with age, dispersed over the body generally, but largest and most prominent at the lower part. Aperture circular and contracted in the young or globular forms (fig. 2, *b*), elliptical elongate in the ovate, and patulous in the old, worn or cup-like form (fig. 1, *d*); leading into a cavity of much the same shape as that of the sponge externally. Sessile or fixed by the anchoring-spicules. Colour grey. External surface uniformly even, except where interrupted by the mammiform prolongations of the body; cribellate immediately below the latticework layer, surmounted by one form of spicule *only*, which issues, as before stated, in hair-like locks from the summits of the prolongations, and will be more particularly described hereafter. Internal surface, or that of the cavity, uniformly smooth, interrupted by depressions or pits (fig. 1, *e e*), so increasing in size downwards as to occupy the whole of the lower part. Body or wall the same as in the foregoing species. External or dermal surface covered by the same kind of latticework. Pores and vents the same respectively. Spicules of three kinds, viz. appendicular, structural, and flesh-spicules. A. Appendicular, of one form only, viz. the "anchoring" one, no. 2 in the fore-



going description, but much larger and longer, increasing in size towards the lower part, where they are 6 inches in length. B. Structural, the same as in the foregoing species, but with *no* spines on the shaft or arms of the crucially headed one. C. Flesh-spicules of eight forms (see 'Annals,' 1873, vol. xii. pl. xiii.), viz. figs. 1, 2, 3, 4, 5, 6, 8, and 12 inclusively, only that figs. 2, 3, and 4 in *R. philippensis* are subspinous in all their parts. Size of the largest specimen, which is cup-shaped (fig. 1), 2 inches high, and  $2\frac{5}{12}$  inches by  $1\frac{7}{12}$  inch wide at the orifice; cup 1 inch deep, with thick rounded margin. Longest hair-like locks of anchoring-spicules 6 inches. Size of ovoid specimen  $1\frac{1}{2}$  by  $1\frac{1}{2}$  inch in its greatest diameters. Size of the three other specimens, which are younger, globular, and linked together by the hair-like locks of the largest (as in figs. 1 & 2, *f*), different, probably in accordance with their ages respectively.

*Hab.* Marine.

*Loc.* Cebu, Philippine Islands.

*Obs.* The hexactinellid character of the spicules of this sponge, coupled with its four-hooked anchoring-spicule (no. 2) as described in the last species, at once proves it to be a *Rossella*; and the absence of the crucially headed veil-spicule from the surface of the body generally (that is, the absence of the "veil"), whose presence is so characteristic of *R. antarctica* and *R. velata*, further proves it to be the *R. philippensis* of Dr. Gray. To this we might add the much greater development in size and length of the groups of anchoring-spicules, the absence of spines on the arms of the large crucially headed structural spicules of the body, and the absence, for the most part, of the outer and inner arm of the latticework sexradiate spicule of the surface, thus leaving the four *horizontal* ones alone developed; while the absence of the erect fringe of spicules around the aperture, whose presence is so characteristic of *R. antarctica*, further distinguishes it from that species.

It is not improbable that the "cup-like form" above described and figured (Pl. X. fig. 1) has had its cavity and shape worn down, and has become modified generally into its present condition from a younger and more globular form with contracted aperture, somewhat like fig. 2; while, so far as these changes go, there may be similar differences between the older and younger forms also of *R. antarctica*; but although such may be thus anticipated, I am not, from the few specimens from which I have had to write my descriptions, able to make the statement with certainty.

In studying the Spongida it will be found that the general form so often varies, that alone it is not to be depended on as

a specific distinction, any more than the same complement of spicules is always accompanied by the same form of sponge: thus, two sponges may be almost undistinguishable in their general forms, and yet, after all, be totally different in the forms of their spicules respectively. Hence the necessity of examining *every* specimen of sponge *microscopically* before we decide on its specific characters.

As in *R. antarctica*, so here we have younger specimens of *R. philippensis* (fig. 2) growing upon the hair-like locks of the older ones (fig. 1, *f*), but much larger in dimensions, similar to those noticed in the concluding part of my description, which suggested to Dr. Gray the name of "*Psetalia globulosa*" (*l. c.*). But whether originating in ova or pullulation I am, as above stated with reference to the minute ones on *R. antarctica*, unable to determine.

Lastly, it might be observed generally that although the hooked extremities of the anchoring-spicules have been for the most part torn off, there are many among them, especially coming from the upper part of the sponge, which naturally have never had any, but have always been fine-pointed.

*Rossella velata*, Wyville Thomson ('The Depths of the Sea,' p. 418).

General form ovoid, hollow; truncate and open at the upper, closed at the lower end. Aperture subcircular, slightly widening inwards from a thin margin to a cavity of much the same shape as the sponge itself externally. Sessile or fixed by anchoring-spicules. Colour brownish grey. External surface uniformly net-like and monticular, resting on a widely cancellated structure below, and covered by the latticework spicular layer above, which is again surmounted by three forms of appendicular spicules, whose relative positions and forms will be described hereafter. Internal surface or that of the cavity, the structure of the body or wall, and that of the latticework layer the same as in both the foregoing species. Pores and vents respectively the same in form and situation. Monticules of the surface round or boss-like, looking like so many stelliform eminences regularly linked together by interradiating lines. Spicules of three kinds, viz. appendicular, structural, and flesh-spicules. A. Appendicular of three forms, viz. 1, pointed at each extremity, and 2, four-hooked at the free end (like nos. 1 and 2 in *R. antarctica* respectively), associated, scantily scattered over the upper part of the body in small groups issuing from the summits of the boss-like eminences, becoming more numerous towards the lower part, where they attain

their maximum size, length, and density—average length  $3\frac{1}{2}$  inches: 3. crucially headed, like no. 3 in *R. antarctica* and similarly situated (that is, issuing from the summits of the monticular or boss-like eminences), but larger and more numerous, averaging in the length of the shaft 7-12ths, and in that of the arms 6-12ths of an inch respectively. B. Structural spicules of the body and latticework layer, the same as in *R. antarctica*. C. Flesh-spicules, the same as those in *R. philippensis*. Size of entire specimen  $2\frac{1}{2}$  by 2 inches in its greatest diameters; aperture 8-12ths of an inch wide; cavity  $1\frac{1}{2}$  inch deep.

*Hab.* Marine.

*Loc.* Atlantic Ocean-bed, north-west of the Shetland Islands.

*Obs.* The specimen of *R. velata* from which the above description has been taken is that figured by Prof. Thomson in his 'Depths of the Sea' (p. 418). It came to me dry and not labelled; but in a jar numbered "65," received also at the same time, there are, among other sponges, three fragments of *R. velata*, which, according to the position of the station which is indicated by this no. (viz. about 80 miles north-west of the Shetland Islands), must have been dredged up in 345 fathoms. Nothing, however, can give a better idea of the sponge, except seeing it, than the representation to which I have alluded; and therefore it will not be here repeated.

*R. velata* differs from *R. antarctica* in the absence of the erect fringe of spicules round the aperture, and, of course, in not possessing that form of *rosette* or flesh-spicule which is peculiar to the latter. It differs from *R. philippensis* in possessing the covering of veil-spicules, whose crucially armed heads form by intercrossing with each other an external envelope common to both *R. antarctica* and *R. velata*, as well as in the absence of the peculiar form of *rosette* in *R. antarctica*.

From *R. philippensis* it also differs in possessing the stelliform boss-like surface, and in the absence of the mammiform prolongations of the body with the large hair-like locks of anchoring-spicules that issue from them respectively, which are equally absent in *R. antarctica* (Pl. X. figs. 1 & 4); lastly, in having for the most part the outer and inner arm of the sexradiate spicule of the latticework dermal layer developed as in *R. antarctica*, together with a profusion of veil-like spicules, with probably other minor differences, which being merely in degree do not merit further mention here, although generally they indicate, from their delicate nature when compared with the other species, the quiet habitat in which *R. velata* has been developed.

*General Observations.*

The essential differences between the species of *Rossella* above described are as follows:—

*R. antarctica* differs from the other two in possessing an erect fringe of stout spicules round the aperture and the peculiar form of *rosette* flesh-spicule above described.

*R. philippensis* differs from *R. antarctica* and *R. velata* in not possessing the monticular or boss-like surface, together with the veil-like covering of crucially headed spicules, but in lieu thereof probably the mammiform prolongations of the body with the large hair-like locks of anchoring-spicules issuing from them respectively.

*R. velata* differs from *R. antarctica* in not having the form of *rosette* peculiar to the latter, and from *R. philippensis* in possessing the veil-like covering of crucially headed spicules.

EXPLANATION OF PLATE X.

- Fig. 1.* *Rossella philippensis*, Gray, old individual, natural size; cup-like and much worn: *a*, body; *b b b*, mammiform prolongations of the body; *c c c c*, hair-like locks of long anchoring-spicules issuing from the prolongations; *d*, cavity or cup-like excavation of the body; *e e*, pit-like depressions on the surface of the same; *f*, hair-like lock of spicules on which a young individual of the same species has become developed.
- Fig. 2.* The same, young specimen which has become developed on the hair-like lock of fig. 1, *f*, natural size: *a*, body; *b*, aperture; *c c*, mammiform prolongations of the body supporting the hair-like locks of spicules respectively.
- Fig. 3.* Form of free end of the anchoring-spicule characteristic of the genus *Rossella*.
- Fig. 4.* *Rossella antarctica*, Carter, natural size, from the largest of two specimens dredged up by Sir J. Ross in  $74\frac{1}{2}^{\circ}$  south latitude: *a*, body; *b b*, external or veil-like covering composed of crucially headed spicules; *c*, erect fringe of spicules round the aperture; *d d*, anchoring-spicules of the lower extremity; *e e*, dotted line indicating the shape of the cavity.
- Fig. 5.* The same, apertural end: *a*, aperture.
- Fig. 6.* Form of *rosette* or flesh-spicule peculiar to *R. antarctica*: *a*, arms subspsined; *b*, four-rayed head; *c*, six-rayed head; *d*, end of a single ray, more magnified, to show that it is capitate and microspined over the shaft.
- Fig. 7.* *R. antarctica*, "pappiform rosette," magnified to the same scale as the foregoing, viz. 1-12th to 1-6000th of an inch, to show their sizes relatively: *a*, arms of the rosette; *b*, head of one arm with rays.

N.B. For convenience only one head of rays has here been inserted.

XV.—*Descriptions of Species of Hippothoa and Alecto from the Lower Silurian Rocks of Ohio, with a Description of Aulopora arachnoidea, Hall.* By H. ALLEYNE NICHOLSON, M.D., D.Sc., F.R.S.E., Professor of Biology in the College of Physical Science, Newcastle-on-Tyne\*.

[Plate XI.]

THE fossils upon which the following communication is founded were in the first place kindly submitted to me for examination and description by Mr. U. P. James, of Cincinnati, an accomplished and experienced observer, and a studious worker in the richly fossiliferous Silurian strata of the State of Ohio. Subsequently I had the opportunity of visiting Ohio personally, and I obtained a large additional series of these forms at Cincinnati and at Waynesville. They constitute a small group of organisms which may be advantageously considered together, though differing considerably in their nature. The first of them is the *Alecto inflata* of Hall, which is an undoubted Polyzoan, though certainly referable to another genus. I have examined very carefully a number of beautifully preserved specimens, and am able to give a more complete description of its characters than has yet been published. Three species (viz. *A. frondosa*, *A. auloporoides*, and *A. confusa*) appear to me to be undoubted examples of *Alecto*, and they all would seem to be new. Lastly, I have appended a description of *Aulopora arachnoidea*, Hall, because this form, whilst seeming to be a genuine *Aulopora*, presents certain striking points of resemblance to *Alecto auloporoides*, with which it might readily be confounded.

1. *Hippothoa inflata*, Hall. Pl. XI. figs. 1, 1 a.

*Alecto inflata*, Hall, Pal. N. Y. vol. i. p. 77, pl. xxvi. figs. 7 a, 7 b.

Polyzoary creeping, adnate, branched, and forming a close but irregular network. Branches linear; cells uniserial, pyriform, each springing by a contracted base directly from the cell below; about four cells in the space of one line. Cell-mouths smaller in diameter than the expanded end of the cell, subterminal, and placed more or less distinctly on the front face of the cell.

Though in some respects resembling some of the species of *Alecto*, I think there can be no hesitation in referring this beautiful species to the genus *Hippothoa*, with which it agrees

\* Communicated by the Author, having been read at the meeting of the British Association at Belfast, before Section C.

in the form and mode of growth of the cells, and in the position of the cell-mouths. It is very readily distinguished from the following forms by the fact that the cells are not at all immersed, by the fact that each cell springs directly from another, by the cells being strictly uniserial, and by the position of the cell-mouth on the front face of the swollen cell. The cells are distinctly pyriform in shape, attenuated below, with a smooth surface, the aperture being orbicular or oval and destitute of notches or spines. The network formed by the polyzoary is usually a very close one, the branches being given off from the sides of the cells, usually at intervals of from half a line to two thirds of a line.

All the examples of this species which I have seen are parasitic upon *Strophomena alternata*, Conrad. Hall's specimens are from the Trenton Limestone; but there can be no question as to their identity with ours.

*Locality and Formation.*—Abundant in the Cincinnati Group (Hudson-River Formation) near Cincinnati, Ohio.

## 2. *Alecto auloporoides*, Nicholson. Pl. XI. figs. 2-2 b.

Polyzoary creeping, adnate, of narrow branches, which divide at various angles and repeatedly inosculate, so as to give rise to a complicated network, the meshes of which are more or less elliptical, and have a long diameter of one line more or less. The branches vary in width from one fifth to one third of a line. Cells tubular, partially immersed, free towards their apertures, sometimes uniserial, more commonly arranged in two alternating rows, sometimes irregularly disposed at the points of anastomosis of the branches; from five to six cells in the space of one line in the narrower branches. Cell-apertures terminal, circular, of the same diameter as the tube, the last portion of the cell being more or less conspicuously developed above the general surface. Surface apparently smooth.

The Ohio palæontologists appear to regard this as being the *Aulopora arachnoidea* of Hall; and, indeed, it seems probable that Hall included this under his species. This, however, is an undoubted *Alecto*; and I think the name of *Aulopora arachnoidea* ought to be restricted to the form which I shall shortly describe under this name—a form which is very similar in general appearance to *Alecto auloporoides*, and occurs with it in the same beds, but which seems certainly to be an *Aulopora*, and is at any rate specifically distinct from the present fossil.

*Alecto auloporoides* is very nearly allied to *A. frondosa*,

James, from which it is distinguished mainly by its more slender habit and graceful form, and by its generally having its cells arranged in a double or single series. Also, I have not hitherto been able to make out in the texture of *A. auloporoides* the minute pores which seem to be present in all perfect examples of *A. frondosa*.

*Locality and Formation*.—Cincinnati Group, Cincinnati, Ohio. The species is a common one, and is found upon *Strophomena alternata*, Conrad, and *Streptelasma corniculum*, Hall.

### 3. *Alecto frondosa*, James. Pl. XI. figs. 3-3 d.

*Aulopora frondosa*, James. Named, but not figured or described, in the 'Catalogue of the Lower Silurian Fossils of the Cincinnati Group,' 1871.

Polyzoary creeping, adnate, of reticulating and anastomosing branches, which usually become more or less completely confluent so as to give rise to a thin expanded crust, or which are partially reticulated and partially confluent. When the branches form a network, the size of the meshes, as well as their disposition, is exceedingly variable; but they are usually more or less oval, with a long diameter of half a line to a line or more, the interspaces between them varying from half a line to two lines. The cells are uniserial on the narrowest branches, but biserial, triserial, or multiserial on other parts of the cœnœcium; elongated and tubular, immersed below, but free towards their apertures, the terminal portion of the tube being more or less elevated above the general surface. Cells from six to eight in the space of one line. Cell-mouths terminal, circular, of the same diameter as the tube. Entire surface, in well preserved specimens, minutely porous.

There does not appear to be any reason for doubting that this is a true *Alecto*. It is nearly allied to *A. auloporoides*, especially as regards the form of the cells; but the greater width of the branches and their common coalescence into expanded crusts, together with the greater number of the rows of cells over most portions of the cœnœcium, communicate to the fossil quite a peculiar appearance, and appear to be characters of specific value. Since my original description of this species, founded on type specimens furnished me by Mr. James, was written (in the Report on the Fossil Corals, Polyzoa, and Sponges of the State of Ohio, now in course of publication), I have examined a large suite of specimens which I collected myself at Cincinnati. These enable me to assert that, in all well-preserved examples, the entire surface of the polyzoary is covered with the apertures of exceedingly

small circular tubes, rendering it minutely porous (Pl. XI. fig. 3 *d*).

The examples of *A. frondosa* which have come under my observation are most commonly attached to the valves of *Strophomena alternata*, *S. planumbona*, and *Orthis occidentalis*; but I have also seen the crusts growing on *Chaetetes frondosus* and *C. mammulatus*.

*Locality and Formation*.—Hudson-River Group (Lower Silurian), Cincinnati and Waynesville, Ohio. The specimens figured are reticulated examples, and are not so characteristic as the expanded and confluent forms.

#### 4. *Alecto confusa*, Nicholson. Pl. XI. fig. 4.

Polyzoary adnate, forming thin crusts which envelop foreign bodies. Cells tubular, multiserial, arranged in irregular transverse rows, immersed towards their bases, free and elevated above the surface towards their apertures. Cell-mouths circular, terminal, as large as the diameter of the tube, about five in the space of one line.

All the examples of this species that I have seen are parasitic upon the columns of Crinoids, which they closely embrace and incrust; and they might readily be referred to *Aulopora*, unless care were exercised. The species is nearly allied in essentials to the two preceding, but is distinguished by its constantly forming thin crusts, and by its larger, more closely and irregularly arranged, and more prominent cells.

*Locality and Formation*.—Cincinnati Group, Cincinnati, Ohio. Collected by Mr. U. P. James.

#### 5. *Aulopora arachnoidea*, Hall. Pl. XI. figs. 5, 5 *a*.

*Aulopora arachnoidea*, Hall, Pal. N. Y. vol. i. p. 76, pl. xxvi. figs. 6 *a*-6 *c*.

Corallum very slender and delicate, attached to the surface of foreign bodies, repeatedly branching, and in many examples anastomosing to form a network. The branches are usually given off at intervals of from one third to two thirds of a line, and are very narrow and linear, not exceeding one fifth of a line in width. The corallites have much the form and character of the cells of the uniserial forms of *Alecto*, being invariably arranged in single lines and opening in the axis of the branches. The terminal portion of the corallite is elevated above the surface; and the calices are circular and not expanded. About four or five calices occupy the space of one line.



Some examples of this species are branched with tolerable regularity, as in the specimen figured; but others form compressed and closely interlaced reticulations. No positive or absolutely definite characters can be stated which would lead to the reference of this fossil to *Aulopora* rather than to *Alecto*. Nevertheless the general aspect of the fossil is such that it can almost positively be placed under the former genus. The forms to which it presents the nearest alliance are *A. filiformis*, Billings, and *A. (?) canadensis*, Nich., both of which are Devonian; but it is readily distinguished from these, and by no character more conspicuously than by the fact that the corallites open in the axis of the branches, instead of making an angle with the main stems. With a little care, also, there is no great difficulty in separating it from *Alecto auloporoides*, to which it presents a very considerable superficial resemblance.

The examples of *Aulopora arachnoidea* described by Hall are from the Trenton Limestone; but ours are from a higher horizon. The specimens which I have seen are all attached parasitically to the surface of different species of *Chatetes* (*Monticulipora*).

*Locality and Formation.*—Cincinnati Group, Cincinnati and Waynesville, Ohio.

#### EXPLANATION OF PLATE XI.

- Fig. 1.* *Hippothoa inflata*, Hall, sp., a small fragment, greatly enlarged. 1 a. Two of the cells of the same, still further enlarged.
- Fig. 2.* *Alecto auloporoides*, Nich., a portion of the polyzoary growing on *Strophomena alternata*, greatly enlarged. 2 a. Portion of a branch of the same, still further enlarged, showing the biserial cells. 2 b. Portion of another branch, in which the cells are uniserial below and biserial above.
- Fig. 3.* *Alecto frondosa*, James, a reticulated example, of the natural size, growing on *Strophomena alternata*. 3 a. Portion of the same, enlarged. 3 b. Portion of the same, still further enlarged. 3 c. Portion of the polyzoary of another specimen, enlarged. 3 d. Portion of another specimen, enlarged, showing the minutely porous nature of the surface.
- Fig. 4.* *Alecto confusa*, Nich., forming a crust on a crinoidal column, enlarged.
- Fig. 5.* *Aulopora arachnoidea*, Hall, a specimen in which the branching is regular and no close reticulation is formed, growing on *Chatetes gracilis*, of the natural size and enlarged. 5 a. Portion of a branch of the same, greatly enlarged.

XVI.—*Description of a supposed new Genus of Ceylon Batrachians.* By W. FERGUSON, F.L.S.\*

TRACHYCEPHALUS.

Fingers and toes tapering, very slightly webbed. Lower jaw with marked but not prominent apophyses, with a small fang-like process in the centre; the internal openings of the nostrils and Eustachian tubes small; tympanum small, but conspicuous. Small parotoids present? The transverse processes of the sacral region dilated. (Maxillary and vomerine teeth present.) Vomer with two separate toothed prominences. A toothed prominence on each side between the choanæ and the jaw. The upper eyelid well developed, but not prominent. A cutaneous fold between the fore and hind limbs.

*Trachycephalus ceylanicus.*

Head very broad, much depressed, and very short in proportion to its breadth, the upper lip having a marked rim all along it, forming nearly a section of a circle, somewhat convex in front; the whole of the upper part of the head, including the eyelids and the tympanic region, covered with small, irregular, granular tubercles. Snout considerably pointed, with its extremity prominent and perpendicularly truncated, and very slightly overreaching the cleft of the mouth. Canthus rostralis obtuse; loreal region concave, with a smooth groove running through it from the lower part of the orbit to the nostril. Occiput deeply concave. Nostril slightly below the extreme end of the canthus rostralis and the snout. Eye of moderate size, prominent, but concealed from above by the eyelid. Tympanum distinct, one half as large as the eye. A linear fold runs from the hinder edge of the orbit over the tympanum towards the armpit. Cleft of the mouth twice as broad as long; tongue not large, broadly but not deeply notched behind, attached to the gullet nearly its whole length. There is a toothed prominence on each side of the vomer, a little lower than the openings of the nostrils, and running in a straight line across the jaw. Vomerine teeth on long ridges gradually rising from the inner angle of the choanæ, running back and convergent behind, terminating in toothed prominences. Skin of the back, belly, throat, legs, and inside of fore limbs smooth. The whole of the upper part of the head (including the eyelids), the front of the fore limbs, and a re-

\* From the 'Journal of the Ceylon Branch of the Royal Asiatic Society,' 1874, Part 1. Communicated by the Author.

markable cutaneous expansion on the side of the trunk between the fore and hind limbs covered with granule-like tubercles, with a few smaller ones on the tympanum. The smooth portion of the skin of the back is separated from the rough head by a somewhat elevated ridge, caused by a depression of the head, and running in a line across just behind the orbits, and continued into the linear fold behind the tympanum, a good deal like that in the adult *Rana Kuhlii* figured by Dr. Günther, 'Indian Reptiles,' t. xxvi. fig. A. Limbs of moderate length; the length of the body two tenths of an inch longer than the distance of vent from heel. The third finger is about one tenth of an inch longer than the fourth, which is slightly longer than the second; these three fingers form a palmated group in advance of the first, and are very slightly webbed. First finger about half the length of the third. Metatarsus with a small tubercle below the first toe. The fourth toe (including the metatarsus) is exactly one half the length of the body; the third toe is slightly longer than the fifth; a very short web between the first, second, third, and fourth toes only; the fifth appears to be quite free.

Upper parts (in spirits) dark brown, with lighter-coloured spots; outer parts of hind and fore limbs clouded with brown; inner sides and the cutaneous expansion coloured dark grey, with small brown spots; belly dark livid colour; throat suffused with brown.

The following are the dimensions of the only specimen in my possession—length of body 1·8, vent to heel 1·6, hind limbs 2·8, fourth toe (including the metatarsus) 0·9 inches.

I do not know any frog with which to compare this one in its general appearance and character. It is one of a few set aside from my collection by Major Beddome, when on a visit to Colombo lately, and pronounced by that gentleman to be new to science, and which, from a feeling of delicacy, he declined to accept from me. In searching for its place in the synoptical list of the characters of the genera of Batrachians given in page 400 of Günther's work on Indian Reptiles, I felt that it could scarcely be removed from the first division, *b*, of the group of Ground-Frogs; and it seemed most closely allied to the genus *Xenophrys*, of which one species, *X. monticola*, is described and figured by Günther in the work referred to, p. 414, and plate xxvi. fig. H.

In the generic and specific descriptions which I have given for this supposed new Ceylon frog, I have followed the exact order of Dr. Günther's description of the Indian frog above referred to, to facilitate comparisons between the two.

The generic descriptions of *Xenophrys* and *Trachycephalus*  
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(rough head) are in many respects so similar that it is not unlikely the former may be so amended as to include the Ceylon frog; but the very distinct aspects of the two, and some remarkable differences more fully given in the specific description, have induced me to include our Ceylon frog in a new genus with a name indicating its singular *rough head*.

In page 85 of the 'Proceedings of the Asiatic Society of Bengal' for March 1870, the late Dr. Jerdon, in the following extract from his "Notes on Indian Herpetology," has shown that vomerine teeth are present in the genus *Xenophrys*:—"I obtained numerous specimens of *Xenophrys monticola*, Günther, both at Darjeeling and the Khasi hills; it has distinct vomerine teeth, which Günther was unable to detect in the specimens of the British Museum. I also obtained five specimens of a larger species of *Xenophrys* both in Sikkim and the Khasi hills, which I propose describing as *Xenophrys gigas*."

It is very likely that, if these specimens of the undescribed species referred to exist, it may be found that they have peculiarities of structure connecting them with *Xenophrys monticola*, Günther, and our Ceylon frog.

I regret to say that I have only one specimen of this supposed new frog, and that I am not certain as to where it was found, though I believe I caught it on the sides of a stream near Hewisse, in the southern portion of the Western Province, and famous as one of Mr. Thwaites's best botanical districts. I regret also to state that, like many of the earlier frogs caught by me, this one was put into strong spirits, which have shrivelled it up to a certain extent. It is very thin and flat in proportion to its size; and I doubt not that, like species of *Hylorana*, it is a powerful leaper. In the specific description given I have tried not to omit a single character which might assist in the identification of this frog.

The interdigital membrane connecting the first, second, third, and fourth toes is just perceptible; but I have no doubt that in newly caught specimens it will be found quite distinct.

I have marked the presence of *parotoids* with a query, thus (?), because I am not certain whether the slight enlargements behind the orbits are parotoids or not.

Writing about *Rana Kuhlii*, Schl., of Ceylon, W. Theobald, junr., Esq., in his Catalogue of Reptiles in the Museum of the Asiatic Society of Bengal, makes the following very appropriate remarks, which are equally applicable to all the Indian and Ceylon Batrachians and the Geckotidæ:—"There are no reptiles in India in such a confused state as the Ranidæ; and I can add but little towards disentangling the shadowy species, real enough perhaps, but not as yet characterized. The series

in the Museum is a very poor one; and the Ranidæ from all parts of India must be assiduously collected before sound results can be obtained. Let us hope that an urgent appeal for frogs from all parts of India [and Ceylon, W. F.] will be liberally responded to by local naturalists and collectors, without which aid the subject must long remain in its present unsatisfactory state. Each contributor should not send merely the most conspicuous frogs from his neighbourhood, but all the species and varieties he can procure."

As an illustration of the liability to add to and perpetuate the confusion connected with some of the frogs and other reptiles, I may refer to a rare Ceylon frog found first on Adam's Peak several years ago by Dr. Schmarda, Professor of Zoology in the University of Prague. On a fly-sheet after page 21 of the second part of Dr. Kelaart's 'Prodromus of the Faunæ of Ceylon,' published in 1853, this frog is very briefly described by the late Dr. Kelaart under the following name, "*Polypedates* (?) *Schmarda*, n. s. nobis"—the "*Schmarda*" being no doubt a slip of the pen for "*Schmardana*," under which latter name, and under the genus *Ixalus*, Günther refers to this then doubtful frog in his 'Indian Reptiles,' p. 433. Theobald, in his Catalogue referred to, p. 85, gives this frog as follows:—" *Polypedates smaragdinus*, Kelaart; Ceylon. Eyebrows armed with spines. Limbs studded with tubercular sharp-pointed spines. A very peculiar species, and probably a distinct generic form." Jerdon, in the paper referred to, pp. 83, 84, and Anderson, in his list of accessions to the collection of reptiles in the Indian Museum since 1865, refer distinctly to an Indian frog described by Blyth in footnote to p. 48 of Appendix to Kelaart's 'Prod. Faun. Zeyl.' as the *Polypedates smaragdinus*, found on the Khasi hills. The specific name here means *emerald-green*; and Mr. Theobald's *P. smaragdinus* ought to have been *P. Schmardana*. On page 85 of the 'Annals and Magazine of Natural History' for January 1872, containing "Descriptions of some Ceylonese Reptiles and Batrachians" by Dr. Günther, this frog is finally, and I suppose properly, named, though not yet described, as *Ixalus Schmardanus* (Kelaart).

XVII.—On the Genus *Deidamia*, v. W.-S. By JAMES WOOD-MASON, of Queen's College, Oxford.

AT the last meeting of the Asiatic Society of Bengal, held on the 5th of August last, I drew attention to the fact that a Crustacean precisely similar in general structure to several

lately discovered by the 'Challenger,' and upon which Dr. v. Willemoes-Sulim (one of the naturalists to the expedition) had bestowed the name *Deidamia*, had long before been described by Professor Camil Heller under the name of *Polycheles typhlops*. In this remarkable Crustacean the organs of vision are morphologically entirely wanting, just as in *Deidamia*, the position of the eye-stalks being merely indicated by two small black specks. The name *Deidamia* having been held to be inadmissible\*, as having been already employed for a valid genus in another division of Arthropoda, and *Willemoesia* substituted for it upon the daring and, as it seems to me, dangerous assumption that every animal dredged up from so vast a depth as were the *Deidamia* would prove generically different from every thing previously described, I have thought it worth while to translate, for publication in the 'Annals and Magazine of Natural History,' Professor Heller's later and more methodical account of his wonderful blind Crustacean from the Mediterranean. The conclusions that I have arrived at, after a most careful study of Heller's figures and descriptions in comparison with those published in Prof. Wyville Thomson's Reports, are:—

1. That the three species *Polycheles typhlops*, *Deidamia leptodactyla*, and *D. crucifer* cannot be placed in any existing family of crustaceans, recent or fossil, except perhaps the Eryonidæ, the structural characters of which are too incompletely known at present to admit of their being included in it.

2. That the three species in question belong *naturally* to one and the same family.

3. That they cannot be distinguished from one another even *generically*.

I therefore beg to propose for them a new family name, and to regard all three as members of its single genus *Polycheles*, as follows:—

Fam. nov. **Polychelidæ.**

Genus unic. **POLYCHELES**, Heller.

a. *With the four anterior pairs of walking-legs didactyle.*

Species 1. *Polycheles typhlops*, Heller.

2. — *crucifer*, v. W.-S.

b. *With all the walking-legs didactyle.*

3. *Polycheles leptodactyla*, v. W.-S.

\* 'Nature,' 1873, vol. viii. p. 485; 1874, vol. ix. p. 182.

The following is a translation of pp. 209–212 of Professor Heller's work \*, entitled 'Die Crustaceen des südlichen Europa' (Vienna, 1863).

Genus *POLYCHIELES*, C. Heller,

Sitzungsberichte der kais. Akademie der Wissenschaften in  
Wien, Bd. xlv. Abth. i. p. 389.

Integument thin. Cephalothorax longish quadrangular, in front and behind moderately tapering, above quite level from before backwards, and slightly convex from side to side: the fore margin hollowed out, the two lateral angles pointed; between these and the middle line, behind the insertion of the inner antennæ, on each side a triangular notch; the lateral borders sharp, tolerably straight, the hinder border deeply emarginate. The cervical furrow on the upper surface distinct. Eyes rudimentary. Antennæ of moderate length, the external ones inserted below and internal to the inner. Peduncle of the inner (upper) antennæ flattened; the first joint very broad, and provided on the inner side with a long spine directed forwards; the two succeeding joints short; of the two flagella the inner long, the outer short. Peduncle of the outer antennæ somewhat longer than that of the inner; the short triangular basilar joint armed at the anterior extremity with a small spine; the two succeeding joints tolerably long and narrow; the flagella considerably shorter than the whole animal: the leaf-shaped appendage, which proceeds outwards from the basilar joint, narrow, thickly fringed with hairs on the margins, shorter than the peduncle. The external maxillipeds small and slender, somewhat shorter than the peduncle of the lower antennæ, six-jointed, externally without palps; the palp is likewise wanting in the second pair of maxillipeds. The first pair of maxillipeds is much elongated; in other respects formed just as in *Scyllarus*. Sternum narrow; the legs very closely approximated at their bases. The first four pairs of legs didactyle, and the last only terminated by a simple claw. The anterior much longer, though but little stouter, than the succeeding pairs, their several joints strongly compressed; the finger long, straight, and slender; the slight terminal claws strongly bent inwards. The hind body longer than the cephalothorax, at its base almost as broad as this, gradually tapering posteriorly, the upper surface arched from side to side; the strongly deflexed lateral processes tolerably broad and rounded off, especially those of the second segment. The fan-shaped caudal swimmeret well developed; its median

\* For figures *vide* plate vi.

plate brought to a point posteriorly; its lateral plates oval, almost equal in length to the former, the outer ones not divided into two halves by a transverse line. Five pairs of abdominal appendages are present in the male; those of the first segment are slender, with a single spirally coiled terminal plate; on the succeeding ones two long, narrow, terminal plates are always present; on the second, indeed, even a third accessory inner plate is added; the basilar joint is much elongated, but gradually diminishes in length backwards.

This species agrees in the general form of its body with the *Scyllaridæ*, from which, however, it is essentially distinguished by the different form of its antennæ, and by its didactyle legs, as well as by its narrow sternum. With the *Astacidæ* it has nothing in common, beyond the lamellar appendage at the base of the outer antennæ and the didactyle feet, but is in other respects perfectly different in structure from them. The genus conforms most nearly to the fossil crayfish (*Eryon Cuvierii*) from the Solenhofen Slates, described by Desmarest, in that in this latter also a flattened cephalothorax, antennæ, and legs of similar structure are found; the hind body, however, is in that species much narrower than the cephalothorax, and the lamellar appendage at the base of the outer antennæ much enlarged. It forms with that extinct form a transitional group between the *Scyllaridæ* (*Loricata*), on the one hand, and the *Astacidæ* on the other.

*Polycheles typhlops*, C. Heller,

Beiträge zur näheren Kenntniss der Macrouren, Sitzungsber. der  
Akad. der Wiss. 1862, Bd. xlv. p. 392, Taf. i. f. 1-6.

The cephalothorax of this species measures 10 lines in length, in front 5, behind 5·4, and across the middle 6 lines in breadth. The lateral margins are tolerably sharp and distinctly toothed, especially towards the front, the lateral angles projecting, with their points directed forwards and outwards. The flat upper surface is divided by a distinct, anteriorly concave cervical furrow, into an anterior and posterior moiety, the lateral extremities of the same bifurcated outwards into two branches running to the margins, and there enclosing a triangular lateral area. Along the middle there runs from before backwards a sharp toothed ridge; another shorter and weaker longitudinal ridge is found on each side on the hinder half of the cephalothorax, somewhat nearer to the lateral margins than to the middle line. Towards the front on each side lie four or five sharp teeth, one behind the other, in a slightly curved, inwardly convex line; in addition, the whole



upper surface is beset with minute rough tubercles. No distinct eyes are present; at the base of the peduncle of the inner antennæ, on each side, one perceives simply a small roundish black speck as the indication of an organ of vision. The peduncles of the antennæ are tolerably hairy, the internal spine of the peduncle of the inner antennæ longer than the peduncle itself. The anterior legs are very long, and when laid backwards reach beyond the caudal swimmeret: their several joints much compressed, the brachium 7·5, the antebrachium 3·5, the carpus 4, the dactyli 5 lines long; the brachium and antebrachium beset with one or two small spines on their outer margins; the hand is likewise provided on its upper and lower margins with some very fine teeth. The succeeding pairs of legs appear considerably shorter; the hand, particularly of the third and fourth pairs of legs, almost prismatic, quadrangular; the finger slender, slightly hairy; the terminal joint of the fifth pair much shorter than the conical tarsus; the coxa provided on its inner side with two roundish projecting scales, behind which lie the orifices of the male genital organs. The first abdominal segment is flat on its upper surface, the four succeeding furnished with a well-marked salient sharp median ridge, which is prolonged at the end of each segment into an acute anteriorly hamate and incurved spine; this spine is most highly developed on the fourth segment. The median ridge is but little indicated on the sixth segment, and bifurcates anteriorly. The pointed triangular median plate of the caudal swimmeret roughly granulated at the base, provided with two ridges converging towards the tip on the hinder half. The plates of the swimmeret are all strongly ciliated on their margins. Length of the body 2 inches.

A single male specimen of this interesting species, found in the Mediterranean near Sicily, exists in the Zoological Museum at Vienna.

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XVIII.—Notes on certain Genera of Agaristidæ, with Descriptions of new Species. By ARTHUR GARDINER BUTLER, F.L.S., F.Z.S., &c.

[Plate XIII.]

THE following notes I have made during my rearrangement of the Agaristidæ in the collection of the British Museum.

The genera *Hespagarista* and *Damias* (part.), placed by Mr. Walker among the Castnii, are referable to the present family,

as also are the genera *Phasis*, *Massaga*, and *Psychomorpha*, originally placed by him among the Melameridæ and Lithosiidæ.

The genus *Cocytia* appears to me to be somewhat intermediate in character between the Agaristidæ and Zygaenidæ; the antennæ are intermediate in character between *Agarista* and *Coronis*, in which respect it resembles *Burgena* (*B. transducta*): it will come best at the end of the Agaristidæ. Boisduval erects a tribe, *Cocytides*, for its reception.

The genera *Phasis* and *Massaga* were referred to their true position in the first volume of Walker's 'Supplement' (Lep. Het. Suppl. p. 45); but at page 136 of the same volume he describes a species of *Phasis* under the family Melameridæ; the type is now in the Museum collection, and is nearly allied to *P. noctilux*. *Josia? separata* and *Josia? continua* (Lep. Het. vii. pp. 1645, 1646) are referable to the same genus.

The genus *Psychomorpha* is nearly allied to *Alypia*, but has pectinated antennæ.

Dr. Herrich-Schäffer has unaccountably abandoned the type of *Phagorista* (*P. agaristoides*), an insect with pectinated antennæ, applying the name to species of Walker's genus *Metagarista*; in this he has been followed by Walker (Lep. Het. vii. p. 1589, & Suppl. i. p. 59 & v. p. 1859) and Moore (P. Z. S. 1865, &c.). Walker's genus must therefore be restored, and will contain the following species quoted in his Catalogue:—*M. transiens* (*Eusemia transiens*, Walk.), *M. bala* (*Phag. bala*, Moore), *M. catocalina* (*Phag. catocalina*, Walk.), *M. leucomela* (*Phag. leucomela*, H.-Sch.), *M. triphaenoides* (*Phag. triphaenoides*, Walk.), *M. longipennis* (*Catocala? longipennis*, Walk.).

The genus *Callidula* (*Damias*, part., Boisduval) is certainly not Agaristid; it appears to me to be better placed with the Melameridæ; *Cleosiris* would also come better with that group: the antennæ in both of these genera are short and hair-like; whereas the antennæ of the typical Agaristidæ are generally long, and always thickened towards the extremity, as in many butterflies.

The genus *Arycanda*, described by Mr. Walker under the Chalcosiidæ (Lep. Het. Suppl. i. p. 123), was placed by him, in the Collection, next to *Eusemia*\*—a proceeding which may, I fear, have led others into error. What is, however, more unfortunate, is that it is structurally identical with the Lithosiid genus *Tigrideroptera*, H.-Sch., which is again identical with the genus *Panathia*, Guenée, referred to the Geometridous family

\* Probably owing to its resemblance to his *Eusemia mollis*, which will have to be generically separated from *Eusemia*.

Zerenidæ. In fact *Arycanda maculata*, Walk., is closely allied to *Panathia georgiata*, Guenée; whilst *Panathia pervasata*, Walk., is perhaps no more than a variety of *Tigridoptera exul* of Herrich-Schäffer.

The following species are new:—

Genus VITHORA, Moore (allied to *Hesparista*).

*Vithora agrionides*, n. sp.

Resembles *Cystidia stratonice*, Cramer, excepting in the body\*.

♂ ♀. Wings above black; primaries with an interno-median patch cut by the median nervure, and terminating just before first median branch, a large blotch immediately beyond it, within the cell, and an angulated discal band, cut by six black nervures, subhyaline white; secondaries with the basal third and a subangulated discal band, cut by six black nervures, subhyaline white. Body: thorax dark brown, laterally streaked with ochre-yellow in front, collar yellow; abdomen ochre-yellow, with a dorsal series of large dark brown spots and lateral series of narrow small spots; below ochre-yellow; venter with two parallel series of large dark brown spots.

Expanse of wings 2 inches 5 to 6 lines.

Hakodadi (*Whitely*). Coll. B.M.

Genus AGARISTA, Leach.

Before proceeding to describe new species in this genus, I wish to call attention to one or two points in Dr. Boisduval's recent paper.

Speaking of the genera *Eusemia* and *Alypia* (p. 43), Dr. Boisduval says "Nous les avons adoptés plutôt comme divisions que comme genres proprement dits." It appears to me that he has not been careful in separating the species evidently referable to these "divisions." For instance, *Agarista Rosenbergii*, of Felder's unpublished plates, is clearly almost as nearly allied to *Agarista agricola* as to *A. milete*, Cr.; yet Dr. Boisduval commences his genus *Agarista* with *A. agricola*, but places *A. Rosenbergii* as the 24th species of *Eusemia* and between *E. pallida*, Walker, an undoubted *Eusemia*, and "*E. milete*," which is an *Agarista*. The species which follow (*E. luctifera*, *fenestrata*, *semyron*=*chrysospila*, Walk., and *radians*, n. 47) are all *Agaristæ*; the following I have not seen, but suspect that they also belong to the same group:—

\* I have to thank Mr. Stretch for calling my attention to Cramer's figure. *Cystidia* is probably a mimic of *Vithora*.

“*E. conferta*, n. 16”<sup>\*</sup>; *agrius*, n. 31; *pedasus*, n. 32; *zea*, n. 34; *pales*, n. 35.

Then, again, to proceed to more serious errors:—*A. frontinus* (n. 2) belongs to the Noctuidæ, and is identical with *Ophiusa pyrrhargyra*, a common and well-known species which comes in almost every Australian collection. *A. ostorius* (n. 3) also belongs to the Noctuidæ, and is the *Fodina ostorius* of Walker’s list. Dr. Boisduval says it is “très-rare:” this may be the case; but there are four examples in the collection of the British Museum. *A. alienata* (n. 13) is one of the *Catocalinæ*, and will probably form a new genus close to *Ophideres*. *A. lincea* (n. 23) is the *bambucina* of Eschscholtz; it comes only from the Philippines so far as I know; and *A. linceoides* (n. 25) is typical *A. lincea*; we have it from Ké and Ceram: these two, with the *Eusemia-mollis* group, will form a new genus allied to *Eusemia*.

### 1. *Agarista polysticta*, n. sp.

♀. Allied to *A. Lewinii*, but smaller, shorter in the wing, the spots on basal area lighter and more numerous, four on costa (the two nearest to base minute), three increasing in size within the cell, and five (the second and fourth larger and oval) in a straight longitudinal line on interno-median area; postcellular band more angulated, almost divided in the middle; discal series of dots obsolete, excepting near costa; submarginal dots larger, nearly white, seven in number; fringe at apex of primaries and round margin of secondaries white: body below less streaked with orange: primaries below with the discoidal spot close to the postcellular band (which is very irregular, as above): discal dots absent; submarginal dots greyish; secondaries with a small solitary whitish spot at origin of subcostal branches.

Expanse of wings 1 inch 8 lines.

Between Sydney and Moreton Bay (*Damel*). Type, B.M.

Also allied to *A. affinis* and *A. ephyra*.

### 2. *Agarista neptioides*, n. sp.

♀. Wings jet-black, fringe spotted with white; primaries with nine white spots arranged as in *A. Donovanii*, but smaller; no subapical diffused spots (as usual in that species); secondaries with a very narrow central white bar, cut by the nervures, so that at its superior extremity it is divided into three unequal ovoid spots: head black, white-spotted; thorax

\* Unfortunately the British Museum does not possess a copy of Herrich-Schäffer’s ‘*Neussereuropäische Schmetterlinge*.’

and base of abdomen black; remainder of abdomen bright orange, crossed by four black segmental lines: wings below the same as above, excepting that there is a nebulous subcostal greyish streak in primaries: body below less black than above; the femora orange.

Expanse of wings 1 inch 11 lines.

Port Albany, North Australia (*Stevens*). Type, B.M.

Allied to, but very distinct from, *A. Donovanii*; its black-and-white coloration makes it very similar to the butterflies in the *N.-melicerta* group of *Neptis*.

### Genus EUSEMIA, Dalman.

Dr. Boisduval's new species, *E. Lambertiene* (n. 3), of which he justly says that it is "sans contredit, l'une des plus belles du genre," is identical with *E. bisma* of Moore (n. 9). Dr. Boisduval gives Java as the habitat of *E. amatrix* (n. 11), whereas the Javan species is his own *E. clymene* (n. 30); if he refers to the 'Oriental Entomology' he will find that Westwood's species comes from India. *E. emolliens* (n. 17) will go with *E. mollis* into a new genus. *E. saturata* (n. 45) appears to be a *Burgena*; but I have failed to discover the type. *E. ? agoceroïdes* is identical with *Metagarista transiens* of Walker; and *E. ? sabulosa* is a new species of the same genus.

#### 1. *Eusemia silhetensis*, n. sp.

♀. Closely allied to the Nepalese *E. victrix*, but with the central pale yellow band of primaries more transverse, the two patches of which it is formed being placed exactly below one another; one discal subcostal white spot (sometimes obsolete) instead of three in a transverse series; blue marginal area of secondaries considerably broader; differences below much as above.

Expanse of wings 3 inches 4 lines.

Silhet (*Doubleday & Argent*). Two specimens, B.M.

#### 2. *Eusemia orientalis*, n. sp.

♀. Nearly allied to *E. victrix*, much smaller; the central pale yellow band of primaries more irregular; the discal white spots united into a quadrifid white bar; secondaries with the marginal blue area more purple in tint and much narrower: wings below purplish brown, the margins bluish; primaries with markings as above; secondaries with a diffused subapical orange spot.

Expanse of wings 2 inches 6 lines.

Mussooree (*Leadbeater*). Type, B.M.

We have a male and two females of the *E. victrix* of Westwood, all from Nepal; and as they agree entirely in pattern, I do not doubt that the two species described above from different localities are distinct.

### 3. *Eusemia nigripennis*, n. sp.

Like *E. adulatrix*, but with the upper division of the central yellow band of primaries narrower, and the lowermost division much broader; the postcellular yellow spots larger; the discal series of white spots reduced to minute points, and the orange subanal patch of secondaries reduced to a squamose dot.

Expanse of wings 3 inches 2 lines.

Ceylon (*Templeton*). Type, B.M.

We have *E. adulatrix* from Nepal and N. India, and the nearly allied *E. bellatrix* from N. Bengal and Moulmein.

### 4. *Eusemia nipalensis*, n. sp.

♂. Nearly allied to *E. maculatrix* of Silhet, but smaller, and differing in the larger and more angular four central yellow spots of primaries, the brilliant orange (instead of dull deep-red) secondaries, and the bright orange abdomen with narrower transverse black bars: differences below as above.

Expanse of wings 2 inches 10 lines.

Nepal (*Ramsay &c.*). Type, B.M.

This beautiful species is certainly distinct.

### 5. *Eusemia distincta*, n. sp.

Allied to the preceding, but differs in having the two inner yellow spots of primaries narrower and almost touching, and the two outer spots white instead of yellow.

Expanse of wings 3 inches.

Silhet (*Doubleday*). Type, B.M.

Intermediate between *E. nipalensis* and *E. irenea* of Boisduval: all three, as well as several examples of *E. vetula*, two of *E. communicans*, and the following species, were united with *E. maculatrix* by Mr. Walker.

### 6. *Eusemia communis*, n. sp. Pl. XIII. fig. 1.

Allied to *E. communicans* (which is closely allied to the Bornean *E. fasciatrix*), but with the inner white (sometimes ochreous) bar always irregular, and almost invariably more or less interrupted\*; the outer white or ochreous bar dislocated,

\* The examples with ochreous or ochre-tinted band generally have it broken up into two small spots.

very narrow, often interrupted, sometimes almost linear; the discal series of white decreasing spots well marked: secondaries reddish ochreous, similar to *E. communicans*; thorax black; head and tegulae spotted with white; abdomen bright ochre-yellow, banded with black.

Expanse of wings 2 inches 10 lines to 3 inches.

Silhet (*Sowerby & Stainsforth*). Type, B.M.

We have eight examples of this species; although rather variable as regards the transverse bands of primaries, they are all so similar that I have no doubt they represent but one species.

7. *Eusemia villicoides*, n. sp. Pl. XIII. fig. 2.

Allied to *E. vetula*, but with the sulphur-yellow spots of primaries enormously enlarged, the three on basal area uniting into one patch, enclosing two black spots (the upper one rounded within cell, the lower irregular, sometimes uniting with the black at base); the discal yellow spots placed one above the other and subquadrate; submarginal spots as usual, the one at anal angle rather larger; base streaked with plumbaginous, an irregular discal line of the same colour: secondaries orange instead of red; the internal fasciole broken up into two rounded black spots; two large subapical yellow spots upon the black margin: thorax broad and black, pterygodes sulphur-yellow: abdomen orange, transversely barred with grey: wings below paler than above, the yellow spots still larger, so that almost the entire basal half of primaries is pale yellow; secondaries with four elongated apical and two small submarginal pale yellow spots.

Expanse of wings 2 inches 6 lines.

Hakodadi (*Whitely*). Two specimens, B.M.

8. *Eusemia superba*, n. sp. Pl. XIII. fig. 3.

Allied to *E. euphemia*, much larger. Primaries with four white dots at the base of costa; two ochreous dots at base of cell; a small ochreous spot and a plumbaginous dot at base of interno-median interspace, and an ochreous interno-basal dot; four large ochreous spots on basal area, one just before middle of cell, a second, larger, at end of cell, a third, elongated, oblique, crossing the middle of the internal nervure, a fourth, subquadrate, below base of first median branch; an ochreous spot at external angle; a large, ochreous subapical blotch; several plumbaginous streaks between the ochreous spots; secondaries as in *E. euphemia*: thorax black, spotted in front with white: abdomen orange, banded with black: male with

a black anal tuft: primaries below black; a white subcostal liture at base; a large ochreous spot near base of cell; a broad internal testaceous streak; an irregular transverse ochreous band; subanal spot and subapical spot as above: secondaries as above: body black, spotted with white; legs black, varied with orange, and dotted with white.

Expanse of wings 3 inches 2 lines.

♂, Zoolu (*Angas*); ♀, Natal (*Gueinzius*). Type, B.M.

The above is the *E. euphemia*, var.  $\delta$ , of Walker's 'List.' It and the two following may be at once distinguished from *E. euphemia* (irrespective of other characters) by the white-spotted prothorax; in *E. euphemia* the prothorax is orange, longitudinally streaked with black.

### 9. *Eusemia africana*, n. sp.

Nearly allied to *E. euphemia*, from which it may be at once distinguished by the single large central ochreous spot on basal area, extending from the costal to the submedian nervure, and the white-spotted prothorax.

Expanse of wings 2 inches 8 lines.

♂, D'Urban, Feb. 1867 (*Trimen*); ♂ ♀, Natal (*Gueinzius* & *Gooch*); ♂, Zoolu (*Angas*). Type, B.M.

The example from Zoolu is rather smaller than the Natal form. This species is the *E. euphemia*, var.  $\gamma$ , of Walker's 'List,' and is the southern representative of that species, which we have from the coast of Guinea, Ashanti, and the White Nile.

### 10. *Eusemia ochracea*, n. sp.

♀. Allied to *E. euphemia*, but smaller; the wings shorter; the subbasal spots of primaries broader; the subapical elongated spot rather nearer to the apex, and not notched internally; the secondaries bright ochreous, with the usual black border; the prothorax dotted with white.

Expanse of wings 2 inches 2 lines.

Congo (*Richardson*). Type, B.M.

I have seen the male of this species in Mr. Stretch's collection; it is the *E. euphemia*, var.  $\epsilon$ , of Walker's 'List.'

### 11. *Eusemia tricolor*, n. sp.

♀. Allied to *E. hesperoides*: wings above dark brown; primaries with a central, oblique, creamy-whitish band, tapering from the subcostal nervure near end of cell to near the external angle, diffused internally from the median nervure



downwards, and slightly interrupted by the first and second branches; apical fringe white; secondaries with a broad tawny patch extending from the middle of the internal margin to the subcostal nervure, where it terminates in an obtuse point: thorax dark brown; a pale yellow fringe on the anterior margin of the collar: abdomen orange (much rubbed in the type); apical fringe white: wings below nearly as above; body below dull ochreous.

Expanse of wings 2 inches 10 lines.

Sarawak (*Wallace*). Type, B.M.

Possibly the female of *E. hesperoides*; but the latter species has the central band of primaries shorter, broader, not diffused or interrupted; the tawny orange patch in secondaries only extended to the origin of third median branch; the collar ochreous; the underside of the wings shot with purple and green; the body, costa of primaries, and a broad central diffused band bright orange.

#### 12. *Eusemia pulchra*, n. sp. Pl. XIII. fig. 4.

♀. Primaries above black; a broad oblique stramineous band from middle of costa to near external angle; apical fringe white; secondaries deep reddish tawny, with the base and a broad external border black; fringe white: thorax black; front of collar white: abdomen orange-tawny: primaries below dull black, shot with blue; veins brown; central band broader than above, creamy white; apical fringe white: secondaries rather paler than above; base and outer margin shot with green and crossed by brown nervures: body ochreous.

Expanse of wings 2 inches 9 lines.

Muhrut, India (*F. Walker*). Type, B.M.

This species was presented to the Collection by the Rev. F. Walker.

#### 13. *Eusemia vittata*, n. sp.

Allied to *E. Belangerii* and *E. Moorei*. Primaries dark brown; a small elongate spot just below median nervure at basal fourth of wing, and a broad, rather irregular, postmedian oblique band from costal nervure to near external angle, sulphur-yellow; cell transversely streaked with plumbaginous; a transverse series of six plumbaginous spots just beyond the yellow band: secondaries salmon-colour; costal area brown; a central subcostal spot, touching the costal area, and a deeply excavated broad marginal border dark brown: thorax dark brown; antennæ silvery whitish; abdomen ochreous, barred with black: wings below paler than above; primaries without

plumbaginous spots or streaks, the small yellow spot replaced by a pale brown one; interno-basal area pale silky brown; secondaries orange, with a broad irregular costal and external brown border: thorax brown; abdomen ochreous, narrowly transversely barred with black.

Expanse of wings 2 inches 2 lines.

Java (*Horsfield*). Type, B.M.

At once distinguished from its allies by the plumbaginous markings and yellow dot on primaries, and the subcostal brown spot of secondaries.

### Family Cocytiidæ.

(*Cocytides*, Boisd.)

Genus COCYTIA, Boisd.

#### 1. *Cocytia chlorosoma*, n. sp.

♂. Nearly allied to *C. Durvillei* ♂, but smaller, shorter in the wing, with the palpi slightly shorter, antennæ and legs more slender, the black margins of the wings considerably narrower, the internervular folds much less strongly blackened, the orange spot at base of primaries about one fourth the size; a small yellow tuft above the anus.

Expanse of wings 3 inches 1 line.

Aru (*Wallace*). Type, B.M.

I have no doubt that this is a distinct species.

### EXPLANATION OF PLATE XIII.

*Fig. 1. Eusemia communis* (spotted ochre-tinted form), p. 140. n. 6.

*Fig. 2. — villicoides*, p. 141. n. 7.

*Fig. 3. — superba*, p. 141. n. 8.

*Fig. 4. — pulchra*, p. 143. n. 12.

XIX.—*Descriptions of new Species of Gobiidæ in the Collection of the British Museum.* By A. W. E. O'SHAUGHNESSY, Assistant in the Natural-History Departments.

*Gobius Burtoni*, sp. n.

D.  $6\frac{1}{10}$ . A.  $\frac{1}{3}$ . L. lat. 38.

The height of the body is one seventh of the total length; the length of the head is comprised four times and a half in the same. Head flattened, broader than high; snout slightly

longer than the diameter of the eye, which is rather more than one fifth of the length of the head. Head naked; small scales on nape. No canines, but the outer series of the teeth enlarged. Upper pectoral rays not silk-like. Ventral rather narrow and tubular, not reaching quite to the vent; pectorals reaching slightly beyond the ventrals, to the vent. Reddish brown, becoming paler on the lower parts of the body; head covered with small black spots and dots; a longitudinal lateral dark brown band from within the axil of the pectoral to the caudal.

One specimen, in the collection of the British Museum, from Fernando Po, was collected by Capt. Burton, after whom it is named. Length  $3\frac{1}{2}$  inches.

*Gobius castaneus*, sp. n.

D.  $7\frac{1}{10}$ . A.  $\frac{1}{10}$ . L. lat. 70-72.

The height of the body is one sixth, the length of the head one fourth, of the total length. Head as broad as high, naked, as well as the nape in one specimen, in the other a few scales in front of the dorsal. Scales small. Interorbital space a little less than the diameter of the eye, which is one fifth of the length of the head. Snout as long as the eye; cleft of the mouth oblique, with the lower jaw prominent. Teeth small; canines none. The first dorsal is not so high as the body; the second is higher than the first, and nearly as high as the body. Caudal rounded. Light brown, deeper on the back; anal and ventral dark-coloured or darker towards their extremities; dorsal fins each with three or four longitudinal rows of dark brown dots; caudal similarly dotted.

Two small specimens in the collection of the British Museum represent this species; they are from Nagasaki.

*Euctenogobius strigatus*, sp. n.

D.  $6\frac{1}{10}$ . A.  $\frac{1}{10}$ . L. lat. 58.

The height of the body is one seventh of the total length; the length of the head is contained four times and a half in the same. The eyes are almost close together, equal to the length of the snout in diameter, and not quite one third of the length of the head. Head naked, nape scaly; the length of the head is double its breadth and height, which are equal. Fourteen longitudinal series of scales between the dorsal and anal fins. Ventral distant from vent by about half its length. First dorsal lower than the second. Reddish brown, with numerous darker narrow vertical streaks on each side of the body from

head to caudal, two dark streaks from eye to mouth; fins variegated with brown, as in *Gobius banana*; a brown mark on upper part of base of pectoral.

One specimen in the British-Museum collection, from Surinam, 3 inches long.

*Euctenogobius latus*, sp. n.

D.  $6\frac{1}{10}$ . A.  $\frac{1}{10}$ . L. lat. 60.

The depth of the body is contained eight times and a half in the total length, being less than half the length of the head, which is very large and broad, its length one fourth of the total, its breadth more than half its length and much greater than its depth. Muzzle prolonged, broad and flattened above, nearly half the length of the head; upper jaw overlapping the lower. Teeth rather stout, in one series only in the upper jaw. Eyes small, on the upper surface of the head; their diameter equal to the interorbital space, and one third of the length of the snout. Head naked. Scales small in front of dorsal, large on the body; thirteen series between dorsal and anal. Ventral not reaching to vent; pectoral longer; first dorsal rather higher than the body and than the second dorsal; caudal rounded, rather more than one sixth of the total length. Reddish or yellowish brown, with dark brown spots and variegations on the sides; fins barred and spotted with dark brown; the second dorsal with regular variegations between the rays; anal grey.

This species presents a considerable resemblance to *Gobius banana* and *G. transandeanus*; but the teeth are distinctly those of *Euctenogobius*. We are not told whether *Gobius dolichocephalus*, Cope, Trans. Amer. Phil. Soc. xiii. p. 403, has the teeth in one or more series in the upper jaw; but a comparison with the descriptions of that species and of *Euctenogobius badius*, Gill, Ann. Lyc. N. H. New York, vii. p. 45, shows that the present species differs considerably from both of them.

One specimen in the collection of the British Museum was collected by Dr. Wucherer at Bahia. Length  $6\frac{1}{4}$  inches.

*Eleotris perniger* (?), Cope, Tr. Am. Phil. Soc. (n. s.) xiv. 1871, p. 473.

D.  $6\frac{1}{5}$ . A.  $\frac{1}{5}$ . L. lat. 56.

A spine at the angle of the præoperculum. Height of body one sixth of total length; length of head contained rather

more than three times and a half in the same. Head thick, obtuse, lower jaw prominent. Eye one sixth of length of head, and contained once and a half in interorbital space. Upper part of head scaly to between the eyes; operculum scaly, præoperculum naked; sixteen series of scales between second dorsal and anal. First dorsal a little lower than the second. Caudal contained five times and a half in total length. Teeth not enlarged. Colour dusky brown; first dorsal whitish at the top and longitudinally streaked with dark brown; second dorsal with numerous longitudinal series of dark-brown spots; caudal barred like second dorsal; other fins dusky. Young specimen much lighter-coloured.

Two specimens, adult and young, in the British-Museum were sent from Bahia by Dr. Wuherer. They differ in several points from Cope's description, but are probably to be referred to the above species.

*Eleotris brevirostris*, Steindachner, Sitzungsab. Akad. Wien, lvi. 1, 1867, p. 314, = *E. compressus*, Krefft, P. Z. S. 1864, p. 184.

*Eleotris Monteiri*, sp. n.

D.  $6\frac{1}{8-9}$ . A.  $\frac{1}{8-9}$ . L. lat. 69.

Resembles *E. fusca*. Præoperculum with spine; scales smaller than in *E. fusca*, particularly on the fore parts of the body. Outer series of teeth not enlarged as in that species; the free portion of the tail also much less in depth and more rounded. Minute scales on head to between eyes, and on opercular bones. Height of body one seventh of total length, and rather more than half the length of the head. Lower jaw the longest, and prominent. Maxillary reaching to beyond the vertical from centre of eye. Interorbital space flat, once and a half the diameter of the eye, which is less than one sixth of the length of the head. First dorsal lower than second, much lower than in *E. fusca*. Caudal elongate, oblong, one fifth of the total length. Colour dark brown above, lighter beneath; fins variegated or clouded with dark brown.

One specimen in the British-Museum collection from the river San Nicolas, Little Fish Bay, in Angola, presented by Mr. Monteiro. Length 5 inches.

*Amblyopus mexicanus*, sp. n.

D.  $6\frac{1}{15}$ . A.  $\frac{1}{15}$ .

Height of body one thirteenth of the total length. Body covered all over with scale-shaped crypts. Head naked.

Dorsal three fourths of height of body. Eye small, but distinct. Snout obtuse; lower jaw advancing a little beyond upper. Teeth small, closely set, the outer series much smaller and more closely set than in *A. Broussonetii*. Dorsal and anal connected with caudal. Upper parts dark brown, with a series of white spots along the whole length of the side; lower parts of sides and body white.

One specimen in the British Museum, from Mexico, purchased. Length 1 foot 8½ inches.

## BIBLIOGRAPHICAL NOTICES.

### *Two Bone-Caves in Switzerland.*

1. ANON. *The Excavation in the Kesslerloch near Thayingen*: 'Alpenpost,' No. 14, April 4, 1874, pp. 196-199, with 2 woodcuts.
2. Prof. ALBERT HEIM. *On a "Find," of the Reindeer Period, in Switzerland*: Mittheil. antiquarisch. Gesellschaft in Zürich, vol. xviii. Heft 5, 1874, pp. 125-135, with a 4to plate.
3. H. KARSTEN. *Studies of the Primeval History of Man in a Cave of the Schaffhausen Jura*: Mittheil. antiq. Ges. vol. xviii. Heft 6, 1874, pp. 139-162, with 4 4to plates.

1. THE Kesslerloch is a cave piercing a spur of the Jura, about a kilomètre west of the railway-station at Thayingen (or Thäingen), in the Canton of Schaffhausen. It opens to the east on the level of the valley along which the railway passes, and to the south-west at about three mètres higher level. Many similar, but smaller, caves are found in the neighbouring hills of upper white Jurassic limestone. Incited by the discoveries made in the many caves of Germany, Belgium, and France, the two masters of the High School of Thayingen, MM. Wepf and Merk, set to work examining this cave in the Christmas holidays of 1873-74. Having removed 1 to 1½ foot of fragments of limestone, they exposed a black layer, a foot or more thick, full of bones and horns and other remains. Beneath this they came upon a red bed, with black and brown patches in it, over 6 feet thick in one place (down to water), and crowded with small flint knives, cores, and flakes, broken marrow-bones, and other evidences of man's early habitation. One of the most interesting specimens was found in the southern half of the cave, on the top of the red bed, about a mètre below the surface, and consists of a piece of subcylindrical Reindeer-antler bearing an incised life-like outline of a Reindeer grazing. The deposits in the cave were horizontal; but the floor of the cave was found to be much lower near the entrance than further back; and it is thought that the higher part was the habitation, and into the lower part the refuse bones, stones, &c. were flung by the old inhabitants. No definite succession of

relics in the red and black deposits was discerned; they were scattered throughout, and, proving to be of the Reindeer Period, indicate this as one of the oldest of the Swiss caves, like those on the Salève and near Villeneuve. Indeed the lowest bed is supposed to be of the Mammoth Period.

No signs of polishing appear on any of the flint implements; and no pottery has been found as yet. The bones are well preserved, and the joint-ends have not been gnawed; the hollow bones, however, have been broken open. Bones of the Hare are most plentiful; next, those of the Reindeer and Stag, and then the Horse. Bird-bones are not rare, especially of the Ptarmigan. Two bones seem to be referable to the Bison or Aurochs. Single bones were met with of the Fox (?), Hyæna (?), and Bear. Lastly, in the lowest bed were found some fragments of a molar of the Mammoth.

Prof. Heim, describing in full the Reindeer figure engraved on the piece of antler, which is carefully illustrated in the plate accompanying the Memoir, insists upon the bold, free, and exact drawing of the old draughtsman, evidently by no means a beginner in his art, and finds reason to show that he was right-handed. In comparing this work of prehistoric art with those found in the Caves of Périgord, and figured by Lartet and Christy in the '*Reliquiæ Aquitanicæ*,' Prof. Heim notices the superior design and effect of this natural and finished figure, as compared with the outlines of Reindeer from that district; but some known outlines of the Aurochs from Périgord (sketched feebly in the '*Matériaux pour l'Hist. de l'Homme*,' vol. v. pl. 21) have equal vigour and truth, and the carver of such poniard-handles as that figured in the '*Reliquiæ Aquitanicæ*,' B. pl. xx., could really represent the Reindeer with exactness and grace. The Swiss Reindeer under notice, with its pinched-up belly, appears to us to be migrating from a poor feeding-ground, perhaps intent on a fresh pasture. Prof. Heim objects to a disproportionate largeness of the head and smallness of the ear. Possibly its poor condition has attenuated the body; or still more likely, knowing the truthfulness of these old artists in other respects, we may believe that this variety of Reindeer had a large head.

Prof. Heim points to other analogies presented by the contents of the Kesslerloch with those of the caves on the Vézère. Piercers made of bone, and broad sharp-edged implements of bone and antler, fragments of the so-called Batons or Pogamagans, barbed harpoons, and fragments of cut antlers were met with, thus corresponding in many respects with the contents of the caves of the Reindeer Period in the south-west of France.

II. After some remarks on the sudden growth of prehistoric studies and on the possibly rash calculations made as to the antiquity of man, H. Karsten states that, with the view of studying these matters for himself, he sought for a cave near Schaffhausen; and, with his friend Dr. E. Joos, he found one in February 1874 fully

answering his purpose. This cave is in the Freudenthal, a little N.-S. valley, opening on the Rhine near Schaffhausen, in the upper white Jurassic limestone, there dipping  $5^{\circ}$  S.E. It is scarcely 70 feet above the valley, under a projecting rock on the eastern slope, which is called the Rosenhalde, about 120 feet high, and forming the western edge of the Reyath plateau. The entrance of the cave was nearly blocked up with the débris covering the hill-side; but it proved to be about 4 feet high and wide, and 10 feet long, leading into a large interior, quite dark, about 50 feet long, 6 feet broad in the middle, and 12 feet high, with the floor sinking towards each side, and rising gently from the middle both inwards and outwards, the former slope being due to the rise of the bottom of the cave, whilst the slope near the entrance was due to the incoming of débris from without. Some bones of a Fox and of a Sheep, with a charred stick, lay about the surface.

By successive diggings, with the aid of Dr. E. Joos, Herr Nüesch (of the High School), Prof. Merklein, and a labourer or two, Herr Karsten found the following succession of deposits:—1. Uppermost, 2 feet of loose limestone fragments, with some bones of recent animals scattered throughout, also some few shards of turned pottery, the lowest at  $1\frac{1}{2}$  foot depth. On the surface were flakes of limestone, containing flint nodules, loosened by frost from the roof.

2. One foot of similar limestone débris, but mixed with marl, more especially downwards, yellow and grey. It contained some bones of Stag, Roe, Fox, Badger, Boar, Goat, and other recent animals, together with fragments of human bones and pieces of very coarse pottery, more abundant than that in the upper bed, and thus distributed to the depth of from 2 to 3 feet. Only one perfect vessel could be restored from the many scattered shards. This pottery is hand-made, ornamented with nail-marks and such like. It corresponds with that of the pile-villages, and, according to Dr. Keller, is similar to that of the Gallo-Celtic period. No stalagmite was met with in the cave; but between the beds No. 1 and No. 2 there is a local bed of loose white calc-tuff, partly pisolitic, without any stones, 1 foot thick and about 2 square mètres in extent.

3. Below the one-foot pottery band is another bed of limestone débris, from 1 to  $1\frac{1}{2}$  foot in the back part, and 2 feet thick in the front part of the cave, mixed with much more clay than in No. 2, and, indeed, in the lowest layers half clay. This bed was full of broken bones of man and beasts, the latter either now extinct or gone from the region (Reindeer, Ibex, Horse, &c.), together with Reindeer-antlers, works of art made of antler and of wood, broken flints and flint knives, so called. Entire flints also occurred in great numbers, and partly of a colour different from that in the upper beds, where a flint nearly 4 cubic feet in size was met with. With the bones &c. occurred also a number of pebbles of quartzose and crystalline rocks, some of which apparently had been used for rubbers, having flat rubbed faces; also smoothing- and polishing-stones of quartzose, argillaceous, and calcareous schists; lastly, a



shell of *Pectunculus* (like *P. violaceus* and *P. glycymeris*), smoothed down, and bored at the umbo. In short, says H. Karsten, we found nearly, if not quite, the same conditions as described by De Tallefer and Saussure ('Archives Sc. Phys. Nat.' 1870) at Veyrier and Ville-neuve on the Lake of Geneva, and by Von Fraas at Schussenreid, and quite the same objects, only more sparingly, as were found close by on the south-east side of the Reyath, near Thayingen\* ('Neues Jahrbuch für Min. Geol. u. Paläont.' 1874, pp. 265-268). As at the places mentioned, and at many others worked out in the Department of Dordogne and in Belgium, the remains of human households are found in this so-called civilization-bed (Culturschicht), without any trace of pottery, under turf-, tuff-, and breccia-deposits, so at the Rosenhalde this bed yields no evidence at all of the existence and use of cooking-vessels. From the entrance nearly to the middle of the cave this bed was streaked grey and black, and contained a larger proportion of flint knives; and some charcoal, burnt bones, and flat pieces of limestone and sandstone, burnt red, here clearly indicated a fireplace or hearth. At the left side, towards which the beds gently sloped, the implements and chips were particularly abundant. The boundary between this implement-bed (1 foot thick on an average) and the loam beneath is not definite; and probably the early cave-dwellers here trod many of their refuse things into the loam softened in rainy weather by drip-water.

4. This lower loam, brownish yellow in colour, was very thin in the back part, and about a foot thick in the fore part of the cave. It had none of the small angular limestone fragments, but contained numerous irregularly shaped nodules, rough to the touch, and mostly penetrated by crystalline veins. Together with flints and small nodules of Bohnerz (concretionary oxide of iron), these nodules occur of all sizes, and belong apparently to the same category as some very large blocks (one measuring half a cubic mètre) which were noticeable in the upper beds. The flint nodules have a white chalk-like crust, as much as 4 lines thick. Some fragmentary bones and molar teeth of Mammoth found in the cave appear to have come from this bed, if, indeed, they do not belong to the lowest part of the bed with flint knives and reindeer-bones.

5. In the back part of the cave, under the loam was a local deposit of tough white clay, without bones or stones, similar to the mammaliferous fire-clay and pottery-clay on the top of the Reyath.

Among the several subjects of interest discussed in this memoir, the author gives his reasons for believing that the cave-folk were cannibals, on account of the split marrow-bones and the peculiarly fractured condition of a piece of human skull found at the Rosenhalde—thus accepting the conclusions arrived at by Spring studying the Chavaux cave, by Jarrigou on the cave near Montesquieu-Avantes, and by Virchow (Address, 'Naturf. Ver. Wiesbaden,' 1873). Remarks also on the probable history of the several deposits, comparisons of the contents of the Rosenhalde cave with those of the

\* See also above, p. 148.

Kesslerloch near Thayingen and other caves, descriptive notes on the several figured specimens of stone, antler, bone, &c., and discussions as to the relative and positive dates of the Cave-dwellers complete the memoir.

The author thinks 4000 years a sufficient period to allow of the habitation of the cave, after the lowest bed with Mammoth-bones had been washed in and the waters drained off, and for the formation of the bed with flint knives and hearth-stuff and subsequent accumulations.

The plates illustrate:—flint-cores and flakes, the latter mostly simple, rarely dressed or worked; simply pointed harpoon-heads, of various patterns and ornament; bone chisels; eyed needle, simple awls and piercers, rippers and smoothers, made of antler; perforated ornaments or charms of wood, shell, and bone; cut antlers; a piece of elephant-bone, and a portion of a human skull fractured by a blunt implement; also a view of the Rosenhalde and diagrams of the cave and its deposits.

*Recherches pour servir à l'Histoire Naturelle des Mammifères, comprenant des Considérations sur la Classification de ces Animaux* par M. H. MILNE-EDWARDS, *des Observations sur l'Hippopotame de Liberia et des Etudes sur la Faune de la Chine et du Thibet orientale* par M. ALPHONSE MILNE-EDWARDS. Tome premier: Texte. Tome second: Atlas, 105 planches. 4to. Paris, 1868 à 1874.

M. MILNE-EDWARDS proposes another scheme for the arrangement of the Mammalia. Like all these schemes, it contains some good points and shows some affinities; but these multitudes of arrangements are of great detriment to the progress of science.

M. Alphonse Milne-Edwards gives a good figure of the Liberian hippopotamus from life, a figure of its skeleton, and details of its skull, brain, &c., the two latter showing that Morton was quite right in regarding this animal as a distinct species and genus from the common hippopotamus, of which some zoologists consider it only a pygmy race.

M. Alphonse Milne-Edwards describes and figures the following new forms of Mammalia from China and Thibet:—

1. *Rhinopithecus Roxellanae*. A monkey with a slightly elongate recurved nose, from Eastern Thibet.
2. *Ailuropus melanoleucus*. A large black-and-white bear with a very short broad head, from Thibet.
3. *Scaptochirus moschatus*. A genus allied to the mole, from Mongolia.
4. *Nyctogale elegans*. An iridescent water-Insectivore.
5. *Scaptonyx fuscicaudatus*; 6. *Uropsilus soricipes*; and 7. *Anourosorex squamipes*. Allied to the shrewmice.

Besides these, he figures and describes, almost all as new:—two

species of *Macacus*, one of *Rhinolophus* (for which he gives a name previously used by Hodgson), one *Vespertilio*, and two species of *Murina*, six of *Felis*, five of *Putorius*, and three of *Meles*, regarding a new species of *Arctonyx* as belonging to this genus; one species of *Talpa*, two of *Sorex*, and one of *Crocidura*; four species of *Siphneus*, three of *Gerbillus*, three of *Cricetus*, two of *Arvicola*, three of *Pteromys*, two of *Sciurus*, one of *Arctomys*, and one of *Spermophilus*; eight species of *Mus*, one of *Rhizomys*, and one of *Lagomys*; four species of *Antelope* of the subgenus *Nemorhedus*, one *Budorcas*, one *Ovis*; three species of *Cervus* (one of which he refers to a new subgenus that he calls *Elaphodes*), one *Cervulus*, one *Moschus*, and one *Sus*. All these constitute a very valuable contribution to Eastern zoology.

J. E. G.

## PROCEEDINGS OF LEARNED SOCIETIES.

### ROYAL SOCIETY.

December 10, 1874.—Joseph Dalton Hooker, C.B., President, in the Chair.

“On the Development of the Teeth of the Newt, Frog, Slowworm, and Green Lizards.” By CHARLES S. TOMES, M.A.

That the “papillary stage” of tooth-development could not be said to exist at any time either in the frog or in certain fish, was pointed out nearly twenty years ago by Professor Huxley, who, however, accepted, on the authority of Goodsir, the latter’s theory of the process as true of Man and Mammalia. In more recent years Kölliker and Waldeyer have traced out the course of the development of teeth with great accuracy in Man and some other Mammalia, with the result of showing that the usually accepted views propounded by Goodsir and Arnold are not by any means an accurate representation of what takes place in them.

Since the date of the publication of Professor Huxley’s paper, I am not aware that any thing has been published bearing upon the development of the teeth of Reptilia and Batrachia, save a paper by Dr. Lionel Beale upon the development of the teeth of the Newt, and a short and inconclusive paper by Santi Sirena; with the exception of the papers alluded to, the subject may be taken to stand in the position which it occupied at the time of the publication of Professor Owen’s ‘Odontography,’ in which we are told that the teeth-germs of Reptiles and Batrachia never stop at the papillary stage, but that the primitive dental papilla sinks into the substance of the gum and becomes inclosed by a capsule.

The principal facts which my observations enable me to state are:—

That there is no such thing as a “dental groove” or “dental fissure” in the Batrachia and Sauria, but that the whole process takes place beneath an unbroken surface of epithelium.

That there is no such thing as a stage of “free papillæ,” and consequently no sinking of papillæ into the gum and subsequent encapsulation of the same.

Instead of being formed in a “dental groove” the teeth are developed in a region which may be termed the area of tooth-development, varying in form and extent in different Reptilia, but agreeing in all in possessing the following characters:—

It is bounded on the one side by the teeth in place and the parapet of bone which carries them, and on the other, or inner, side by an exceedingly sharply defined boundary, consisting of dense connective tissue. At the surface, near where the functional tooth projects above the oral epithelium, it is narrow, but it expands as it passes more deeply below the surface. Within this area are developing tooth-sacs of different ages, the interspaces being occupied by a loose areolar tissue, differing in appearance from that which is seen outside the area, and appearing to be derived from portions of older tooth-sacs, which have not been entirely used up in the formation of the teeth.

The individual tooth-sacs are formed thus: an inflection of the cells of the oral epithelium, in section like a tubular gland, passes down along the inner side of the area above defined, until it reaches nearly to the level of the floor of the area. The depth to which it penetrates is considerable in many forms, *e. g.* in the Lizards, in which, therefore, this double layer of epithelial cells appears a mere line.

At the bottom of this inflection of epithelial cells the adjacent tissue assumes the form of a small eminence (without at first any visible structural alteration), while the epithelial process takes the shape of a bell-like cap over the eminence.

This epithelial inflection then goes to form the enamel-organ; the eminence becomes the dentine-organ.

Thus the enamel-germ is the first thing recognizable, and the presence of this ingrowth of epithelial cells seems to determine the formation of a dentine-organ at that particular spot which lies beneath its termination.

The enamel-organs, after they are fully formed, retain a connexion with epithelial cells, external to the ovoid or spherical tooth-sacs, at their summits; and the enamel-organs of successive teeth appear to be derived from the necks of those of their predecessors rather than from fresh inflections from the surface of the oral epithelium, though I am not sure that this is, in all instances, the case.

The tooth-sac of the newt is entirely cellular, and has no special investment or capsule; under pressure it breaks up and nothing but cells remain, as was noted by Dr. Lionel Beale.

That of the frog has an investment, derived in the main from what may be called the accidental condensation of the surrounding connective tissue, which is pushed out of the way as it grows; while in the lizard the base of the dentine-germ furnishes lateral prolongations, just as has been observed to be the case in man.

The dentine-organs conform closely with those of mammals; the odontoblast layer is very distinct, and the processes passing from these cells into the dentine-tubes are often visible.

The enamel-organs consist only of the outer and inner epithelia, without any stellate intermediate tissue; as, in some instances, enamel is certainly formed, the existence of the stellate tissue is obviously non-essential. When a tooth is moving to displace its predecessor, its sac travels with it, remaining intact until the actual attachment of the tooth to the bone by ankylosis.

“On the Structure and Development of the Teeth of Ophidia.”

By CHARLES S. TOMES, M.A.

Contrary to the opinion expressed by Professor Owen and endorsed by Giebel and all subsequent writers, the author finds that there is no cementum upon the teeth of snakes, the tissue which has been so named proving, both from a study of its physical characters and, yet more conclusively, from its development, to be enamel. The generalization that the teeth of all reptiles consist of dentine and cement, to which is occasionally added enamel, must hence be abandoned.

Without as yet pledging himself to the following opinion, the author believes that in the class of Reptiles the presence of cementum will be found associated with the implantation of the teeth in more or less complete sockets, as in the Crocodiles and Ichthyosaurs.

The tooth-germs of Ophidia consist of a conical dentine-germ, resembling in all save its shape that of other animals, of an enamel-organ, and of a feebly expressed capsule, derived mainly from the condensation of the surrounding connective tissue.

The enamel-organ consists only of a layer of enamel-cells, forming a very regular columnar epithelium, and of a few compressed cells external to this, hardly amounting to a distinct layer; the enamel-organ is coextensive with the dentine-germ. There is no stellate reticulum separating the outer and inner epithelia of the enamel-organ.

The successional teeth are very numerous, no less than seven being often seen in a single section; and their arrangement is peculiar, and quite characteristic of the Ophidia.

The tooth next in order of succession is to be found at the inner side of the base of the tooth in place, where it lies nearly horizontally; but the others stand more nearly vertically, parallel with the jaw and with the tooth in place, the youngest of the series being at the bottom.

The whole row of tooth-sacs is contained within a single general connective-tissue investment, which is entered at the top by the descending process of oral epithelium, whence the enamel-germs are derived.

As they attain considerable length, the forming teeth, which were at first vertical, become nearly horizontal, resuming, of course, their upright position once more when they come into place.

The clue to the whole peculiarity of this arrangement is to be found in the extreme dilatation which the mouth of the snake undergoes. The general capsular investment probably serves to preserve the tooth-sacs from displacement; while, if the forming teeth remained vertical after they had attained to any considerable length, their points would be protruded through the mucous membrane when this was put upon the stretch in the swallowing of prey.

Just as the author has shown in a previous communication to be the case in the *Batrachia* and *Sauria*, the hypothetical "papillary stage" is at no time present.

From the oral epithelium there extends downwards a process which, passing between and winding around the older tooth-sacs, after pursuing a tortuous course, reaches the furthest and lowest extremity of the area of tooth-development. Here its caecal end gives origin to an enamel-organ, and, while it does so, buds forth again beyond it in the form of a caecal extremity. Thus at the bottom of this area of tooth-development there is a perpetual formation of fresh enamel-organs, beneath which arise corresponding dentine-organs, or papillæ, if such they can be called when arising thus far away from the surface.

In essential principle, therefore, the formation of a tooth-germ is similar to that already described in mammals and other reptiles, the difference lying principally in the enormous relative length of, and the tortuous course pursued by, that inflection of the oral epithelium which serves to form the enamel-organs. The attachment of the tooth to the jaw is effected by the rapid development of a coarse bone, which is not derived from the ossification of the feebly expressed tooth-capsule, but from tissues altogether external to it. Nevertheless this coarse bone of attachment adheres more closely to the tooth than to the rest of the jaw, from which, in making sections, it often breaks away.

The base of the dentinal pulp assists in firmly binding the tooth to this new bone, being converted into a layer of irregular dentine.

This "bone of attachment" is almost wholly removed and renewed with the change of each tooth.

## MISCELLANEOUS.

*On some Points in the Anatomy of the Common Mussel (Mytilus edulis).*

By M. A. SABATIER.

IN the mussel the apparatuses of circulation, respiration, and urinary excretion present arrangements which differ in some respects from those observed in the Lamellibranchiate Mollusca generally.

The central apparatus of circulation consists of a heart with two auricles, which does not furnish an aorta at its posterior extremity. This aorta springs from the anterior aorta at the lower surface of the aortic bulb, and passes backward to supply the stomach and intestine. The anterior aorta furnishes the hepatic and tentacular arteries and especially the great parallel arteries which are distributed over the outer surface of the mantle.

The return passages of the blood to the heart are very complex, and vary according to the organs. On each side of the body there is a great vessel, running obliquely from above downwards and from the front backwards, which opens directly into the auricle; this is the *oblique afferent vein*. Its lower extremity opens into a large longitudinal cavity, situated at the level of the adherent margin of the mantle and composed of two parts, a *posterior* and an *anterior longitudinal vein*.

The veins of the mantle are placed on the inner surface. They ascend towards the adherent margin of the mantle, and anastomose below this margin to form a large, zigzag, horizontal vein. From the superior angles of this sinuous trunk spring vertical trunks, which soon subdivide into small canals to penetrate into some special organs, which I shall describe under the name of *plaited* or *frilled organs*. The blood which has traversed these organs penetrates in part into the vascular network of the *corpus Bojani*, and in part into the anterior longitudinal vein. The blood coming from the liver and the anterior visceral mass penetrates directly into the *corpus Bojani*. A small portion of the blood from the mantle passes, also directly, into the oblique afferent vein, and another portion directly into the anterior longitudinal vein.

The *corpus Bojani* is far from presenting the characters seen in it in most Lamellibranchiate Mollusca. It does not form a clearly distinct organ as in these Mollusca; but neither is it entirely composed, as has been asserted, of plates of Bojanian tissue lining the walls of the large veins and auricles. In fact we can distinguish in the *corpus Bojani* of the mussel two different parts—one *autonomous*, the other dependent on the large veins. The autonomous part is anterior, and is to be seen on the lateral portions of the liver, in the furrow which separates that organ from the base of the branchiæ; it is formed of a series of vertical membranous folds, and is of a greenish brown colour. The folds enclose cavities which open successively by their superior extremities into a collecting canal, the diameter of which increases rapidly from before backwards, and which is exactly within the afferent vessel of the branchia.

The portion of the *corpus Bojani* which lines the vascular walls occurs on the walls of the auricle, the oblique afferent vein, and the posterior longitudinal vein. This last vessel is only separated from the posterior half of the collecting duct of the *corpus Bojani* by a spongy lamina or septum of Bojanian tissue, which, being pierced by numerous small orifices, allows of communication between the vessel and the collecting-duct.

The cells constituting the Bojanian tissue are not the same throughout. Those of the autonomous portion and of the septum just mentioned are formed of a very transparent protoplasm, in which there are a very variable number of small green granules; they have no nucleus. Those belonging to the walls of the oblique afferent vein and of the auricle contain, besides the green granules, large colourless nuclei provided with one or two colourless nucleoles; they also contain colourless granules.

The passage from the cells of the first to those of the second kind takes place rather suddenly, which justifies us in thinking that the latter are not exclusively Bojanian, but that they may also fulfil other functions.

The cavity of the pericardium is continuous below, by a passage placed in front of the oblique afferent vein, with the collecting-duct of the *corpus Bojani*. Between the passage and the collecting-duct there is a narrow oblique orifice which allows the passage of a liquid from the passage into the duct, but impedes its return in the opposite direction. The liquid which has traversed the *corpus Bojani* rids itself of certain principles, which are received in the pericardium, the passage, and the collecting-duct. This last communicates with the exterior by a very narrow orifice, placed at the apex of a very small papilla, concealed behind the papillæ of the reproductive organs; the discovery of this orifice is due to M. de Lacaze-Duthiers. The Bojanian collecting-canal receives in part the blood from the veins of the "bosse de Polichinelle" at the level of the branchial ganglia, and opens posteriorly with a large posterior pallial vein, which serves as a canal of derivation for the blood returning from the mantle at those periods when the pallial circulation is very abundant—that is to say, during the period of reproduction.

The organs of respiration are multiple. They include the branchiæ, the surface of the body, and especially the inner surface of the mantle and the *plaited or frilled organs*.

The branchiæ are composed of very small filaments, traversed by a single very narrow canal. These branchial canals originate, for the most part, directly from the Bojanian tissue, others from a branchial afferent vessel of spongy or cavernous structure; they open into an afferent vessel, the diameter of which increases from behind forwards, and which occupies the upper margin of the free lamella of the branchia. This afferent vessel of the branchia receives in front some superficial vessels of the liver, some little veins of the mantle, and the veins of the buccal tentacles, and it opens into the anterior extremity of the anterior longitudinal vein. The branchial



circulation differs greatly in its degree of intensity from the branchial circulation of the other Lamellibranchiate Mollusca; it is very feeble or almost none; branchial injections, moreover, are rarely successful and always very imperfect. This deficiency of circulation depends:— 1, on the small calibre of the branchial vessels; 2, on the weakness of the flow of the blood, which only arrives at the branchiæ after having traversed the Bojanian and other capillary networks; and, 3, on the existence of easy return passages, which allow the blood to return to the heart without having traversed the branchiæ.

The mantle plays an important part as an organ of respiration. But during the period of reproduction it is gorged with eggs or spermatozooids, since it contains the reproductive organs; it acquires a great thickness and becomes a very active visceral organ in which hæmatosis does not take place, and in which, on the contrary, the blood becomes charged with carbonic acid in consequence of the activity of the phenomena of nutrition. The respiratory functions are then performed by the *plaited organs*, which are arranged in a close series on the inner surface and near the adherent margin of the mantle. They have been mistaken for simple vessels; but they are hollow laminæ, very regularly sinuous, and with very elegant foldings. Their cavity is rendered spongy by a true reticulum of very delicate elastic fibres. Their surface is clothed with vertical series of cells with long vibratile cilia, which effect the renewal of the water; the interspaces of these series of cells are occupied by cells with short cilia. These plaited organs receive the blood which returns from the mantle. I regard them as a respiratory organ, a supplementary branchia, destined to play an important part during the period of reproduction, when the mantle does not respire. This opinion is, moreover, in harmony with the fact that the plaited organs are much more prominent and much better filled with blood at the time when the mantle is occupied by the reproductive elements. These plaited organs are therefore neither a part of the *corpus Bojani*, as Siebold believed, nor simple vessels detached from the mantle, as has also been supposed.—*Comptes Rendus*, August 31, 1874, vol. lxxix. pp. 581–584.

#### Note on *Herpeton tentaculatum*.

M. Albert Morice, surgeon in the French navy, has kindly communicated to me that he has succeeded in bringing a living example of this snake to the Zoological Garden in Paris. He observed it in the south-eastern provinces of Camboja; and writes as follows:—

“*Herpeton tentaculatum* is ovo-viviparous, bringing forth six young ones at a birth, which are 0·28 m. long. Its food is mixed; it feeds on tadpoles and small fish, and also on an aquatic plant called by the natives ‘Rân giua,’ or *Jussiaea repens* of botanists.”

A. GÜNTHER.

*Notice of some Freshwater and Terrestrial Rhizopods.*

By PROF. LEIDY.

Prof. Leidy stated that among the amœboid forms noticed by him in the vicinity of Philadelphia, there was one especially remarkable for the comparatively enormous quantity of quartzose sand which it swallowed with its food. The animal might be viewed as a bag of sand! It is a sluggish creature, and when at rest appears as an opaque white, spherical ball, ranging from  $\frac{1}{8}$  to  $\frac{3}{8}$  of a line in diameter. The animal moves slowly, first assuming an oval and then a clavate form. In the oval form one measured  $\frac{3}{7}$  of a line long by  $\frac{2}{7}$  of a line broad; and when it became clavate it was  $\frac{2}{3}$  of a line long by  $\frac{1}{3}$  of a line broad at the advanced thick end. Another, in the clavate form, measured  $\frac{7}{8}$  of a line long by  $\frac{1}{3}$  of a line wide at the thick end. The creature rolls or extends in advance, while it contracts behind. Unless under pressure, it puts forth no pseudopods; and the granular entosarc usually follows closely on the limits of the extending ectosarc. Generally the animal drags after it a quantity of adherent dirt attached to a papillated or villous discoid projection of the body.

The contents of the animal, besides the granular matter and many globules of the entosarc, consist of diatoms, desmids, and confervæ, together with a larger proportion of angular particles of transparent and mostly colourless quartz. Treated with strong mineral acids, so as to destroy all the soft parts, the animal leaves behind more than half its bulk of quartzose sand.

The species may be named *AMŒBA SABULOSA*, and is probably a member of the genus *Pelomyxa* of Dr. Greef (*Archiv f. mikr. Anat.* x. 1873, p. 51).

The animal was first found on the muddy bottom of a pond in Dr. George Smith's place in Upper Darby, Delaware County, but has been found also in ponds in New Jersey.

When the animal was first noticed with its multitude of sand particles, it suggested the probability that it might pertain to a stage of life of *Diffugia*, and that by the fixation of the quartz particles in the exterior, the case of the latter would be formed. This is conjectural, and not confirmed by any observation.

A minute amœboid animal found on *Spirogyra* in a ditch at Cooper's Point, opposite Philadelphia, is of interesting character. The body is hemispherical, yellowish, and consists of a granular entosarc with a number of scattered and well-defined globules, besides a large contractile vesicle. From the body there extends a broad zone, which is colourless, and so exceedingly delicate that it requires a power of 600 diameters to see it favourably. By this zone the animal glides over the surface. Delicate as it is, it evidently possesses a regular structure, though it was not resolved under the best powers of the microscope. The structure probably consists of globular granules of uniform size, alternating with one another, so that the disk at times appears crossed by delicate lines, and at others as if finely and regularly punctated. The body of

the animal measures from  $\frac{1}{80}$  to  $\frac{1}{50}$  of a line in diameter; and the zone is from  $\frac{1}{300}$  to  $\frac{1}{200}$  of a line wide. The species may be named *AMŒBA ZONALIS*.

The interesting researches of Prof. Richard Greef, of Marburg, published in the second volume of Schultze's 'Archiv f. mikroskopische Anatomie,' on *Amœbæ* living in the earth ("Ueber einige in der Erde lebende Amœben, &c."), led me to look in similar positions for Rhizopods.

In the earth, about the roots of mosses growing in the crevices of the bricks of our city pavements, in damp places, besides finding several species of *Amœba*, together with abundance of the common wheel-animalcule, *Rotifer vulgaris*, I had the good fortune to discover a species of *Gromia*. I say good fortune; for it is with the utmost pleasure I have watched this curious creature for hours together. The genus was discovered and well described by Dujardin from two species, one of which, *G. oviformis*, was found in the seas of France; the other, the *G. fluviatilis*, in the river Seine.

Imagine an animal, like one of our autumnal spiders, stationed at the centre of its well-spread net; imagine every thread of this net to be a living extension of the animal, elongating, branching, and becoming confluent so as to form a most intricate net; and imagine every thread to exhibit actively moving currents of a viscid liquid, both outward and inward, carrying along particles of food and dirt, and you have some idea of the general character of a *Gromia*.

The *Gromia* of our pavements is a spherical cream-coloured body, about  $\frac{1}{10}$  of a line in diameter. When detached from its position and placed in water, in a few minutes it projects in all directions a most wonderful and intricate net. Along the threads of this net float minute *Naviculæ* from the neighbourhood, like boats in the current of a stream, until reaching the central mass they are there swallowed. Particles of dirt are also collected from all directions, and are accumulated around the animal; and when the accumulation is sufficient to protect it, the web is withdrawn, and nothing apparently will again induce the animal to produce it.

From these observations we may suppose that the *GROMIA TERRICOLA*, as I propose to name the species, during dry weather remains quiescent and concealed among accumulated dirt in the crevices of our pavements, but that in rains or wet weather the little creature puts forth its living net, which becomes so many avenues along which food is conveyed to the body. As the neighbourhood becomes dry, the net is withdrawn to await another rain. The animal with its extended net can cover an area of nearly half a line in diameter. The threads of the net are less than the  $\frac{1}{30000}$  of an inch in diameter.—*Proc. Acad. Nat. Sci. Phil.* 1874, p. 88.

*On Leucochloridium paradoxum and the Development of the Larvæ contained in it into Distoma.* By DR. ERNST ZELLER.

In this memoir the author gives some new details upon *Leucochloridium*, and especially describes the experiments which have led him to the discovery of the species of *Distomum* into which the *Cercaria* contained in this singular nurse are transformed. We shall dwell here more particularly upon what relates to the migration of this Trematode into its definitive host.

By keeping some *Succineæ* in confinement Dr. Zeller was enabled to observe the growth of the *Leucochloridium* through their integuments. It takes about four weeks for a sac to be developed so as to become visible in the anterior part of the mollusk, and three weeks more for it to acquire its full development.

When one of the sacs has acquired its full dimensions and moved for a certain time in the tentacle of a *Succinea*, the integuments of the mollusk become so thin in this region as to be ruptured by the action of a slight pressure from without. When such a rupture is produced, the *Leucochloridium* projects from the tentacle and continues for a considerable time to move actively, although still adhering at the base by its filiform pedicle. It may be artificially detached from the mollusk without the latter seeming to suffer from the operation. The *Succinea* then remains contracted for some hours; then it begins again to creep and to take food. If it is kept in favourable conditions, another sac may be developed to replace that which has been removed.

M. von Siebold put forward the supposition that the larva (*Cercaria cafoliata*, Moulinié) contained in *Leucochloridium* produced the *Distomum holostomum* which inhabits the rectum of several marsh birds, such as *Rallus aquaticus*, *Gallinula chloropus* and *G. porzana*. Dr. Zeller, on his part, observed *Succineæ* infested by *Leucochloridium* in localities where it seemed to him the waders just mentioned could not be met with, but which were, on the contrary, inhabited by various birds of the family Sylviadæ. He was thus led to suppose that these last might be the true hosts into which the *Leucochloridium* migrated. This supposition seemed to him to become almost a certainty when he found *Distomum macrostomum*, Rud., in a redbreast, as the organization of that species is in almost complete concordance with that of the larva contained in *Leucochloridium*. This *Distomum*, the organization of which the author very carefully describes, has hitherto been observed only in the redbreast and some other species of the same group, such as the nightingale, one or two warblers, and two wagtails. All these birds are insectivorous, and none of them feed upon mollusks. Dr. Zeller supposed that they tore off the *Leucochloridium* from the tentacles of the *Succinea*, as its resemblance to the larva of an insect is striking. To verify this hypothesis he offered to a tame redbreast a *Succinea* containing *Leucochloridia* which had pushed into the tentacles. The bird immediately came down upon one of these

sacs, tore it out of the tentacle, and swallowed it. Several other similar experiments gave the same result. The most interesting was one in which, a mealworm having been placed side by side with a *Succinea*, the author saw a blackcap seize first the *Leucochloridium* and afterwards the mealworm. In all these experiments it was observable that the bird, after having seized the *Leucochloridium* and torn it out with a single strike of the bill, swallowed it, sometimes immediately, sometimes only after striking it several times against the floor of its cage or the perch, thus behaving exactly as the insectivorous birds do with their ordinary food.

From the success of these first experiments Dr. Zeller had great hopes of being able to confirm his hypothesis by the autopsy of the birds. So his disappointment was great when he did not find a single *Distomum macrostomum* in three redbreasts and a blackcap which he dissected some weeks after he had seen them swallow the *Leucochloridia*. He then questioned whether the larvæ of *Distomum* contained in the *Leucochloridia* had been quite *mature*, or whether, perhaps, the artificial nourishment of the birds might not have exercised an injurious influence upon the parasites. In order to avoid these causes of failure he made fresh experiments, employing this time some *Succineæ* which had been kept for a long time in captivity, and containing *Distomum*-larvæ, the development of which could not but be sufficiently advanced; and at the same time, instead of cage-birds, he made use of young birds in a free state, but still in the nest. These birds were shut up with their nests in small cages, and left in a place where they could be fed by their parents.

Three series of experiments, made under these conditions, upon whitethroats (*Curruca garrula*), blackcaps, and wagtails were crowned with full success. The *Distoma* were fixed in the rectum in great numbers and very lively; their reproductive organs presented a state of development more or less advanced, according to the length of time they had remained in the intestinal canal of their host. In some of them the oviducts were to be seen filled with ova, some of which even were already of an intense yellow colour. The development of the larva of *Distomum macrostomum* into the adult animal is very rapid; and the production of the ova seems to commence within six days after the migration.

Dr. Zeller completes his memoir with some observations on the species allied to *D. macrostomum*, and upon the hosts which furnish nourishment for these different species of *Distomum*. He considers that Diesing was wrong in combining with *D. macrostomum* the *D. erraticum* and *D. ringens* of Rudolphi. On the other hand, he convinced himself that *D. mesostomum*, Rud., which occurs in the song-thrush, the grosbeak, the bullfinch, and the greenfinch, is quite distinct from *D. macrostomum*. But *D. holostomum*, Rud., from the water-rails and the common water-hen, which M. von Siebold supposed to be the adult form of the larva of *Leucochlori-*

*diuum*, presents all the same characters as *D. macrostomum*, from which it differs only in size. Its length is from  $\frac{1}{4}$  to  $2\frac{1}{2}$  lines, while that of *D. macrostomum* is only  $\frac{1}{2}$  to  $\frac{2}{3}$  line. These two forms would therefore seem to constitute only a single species, which attains larger dimensions in the Waders than in the Passerine birds.

The author concludes with some remarks upon the singular mimetism presented by the *Leucochloridium*, the resemblance of which to the larva of an insect cannot fail to strike all who examine that singular parasite. In his opinion, this resemblance, destined to deceive insectivorous birds, has a teleological significance; for it does not serve for the protection or preservation of the creature, but rather leads to its destruction. It is true that this destruction is associated with the development of the larvæ contained in it; "but," says the author, "no one can suppose that our *Leucochloridium* thus sacrifices its own existence to secure that of its progeny." Agreed! but no naturalist has ever asserted that mimetism was due to an effect of the will of the creature that imitates. It shows a very erroneous conception of the theory of mimetism, and consequently of that of selection, to suppose that it ascribes the modifications of the species to voluntary actions of the individuals; and we are sorry to see Dr. Zeller make use of the interesting facts that he has discovered in support of such reasoning. In the great struggle for existence the species is all, the individual almost nothing; and what can be more favourable to the preservation of the species than this deceptive imitation which leads to the sacrifice of an individual without organs, such as *Leucochloridium*, in order to secure to the larvæ of the *Distomum* their transportation into the intestine of an insectivorous bird, where they can acquire their definitive development and become fitted to reproduce their kind.—*Zeitschr. für wiss. Zool.* vol. xxiv. (1874), p. 564; *Bibl. Univ., Bull. Sci.* 1874, p. 366.

*The Diatomæ of the Carboniferous Period.*

By Count F. CASTRACANE.

The author believing that, although hitherto undetected, Diatomæ must have existed at the time of the formation of coal, hit upon the ingenious expedient of examining with the microscope the ashes of coal, instead of the thin sections previously studied. In this way he has succeeded in ascertaining the presence in coal, received from Liverpool, of a great number of species of Diatoms. Most of them belong to freshwater genera or species; but the presence of marine species mixed with these seems to prove that the ground in which this coal was formed was in more or less frequent communication with the sea.—*Actes de l'Acad. Pontif. des Nuovi Lincei*, February 1874; *Bibl. Univ., Bull. Sci.* 1874, p. 376.

# THE ANNALS

AND

## MAGAZINE OF NATURAL HISTORY.

[FOURTH SERIES.]

No. 87. MARCH 1875.

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XX.—*On Pelagonemertes Rollestoni.* By H. N. MOSELEY,  
Naturalist on board H.M.S. 'Challenger.'

[Plate XV. B.]

THIS remarkable form was found in the trawl, together with a number of deep-sea animals, from 1800 fathoms, near the southern verge of the South-Australian current, lat.  $50^{\circ} 1' S.$ , long.  $123^{\circ} 4' E.$ , March 7, 1874. Its appearance at once pronounced it a pelagic animal, the body being gelatinous and transparent, as in *Salpa*, with the exception of the alimentary canal, which stood out in relief, being of a deep burnt-sienna colour (as is the nucleus in many *Salpæ*), and the region of the sheath of the proboscis, which was less transparent than the remainder of the body. The animal was living when obtained, and when placed in fresh sea-water gave evidence of life by a feeble irregular peristaltic contraction of the external muscular tunic, which increased on irritation; the proboscis was also protruded and retracted several times.

The animal was about 4 centims. long and 2 broad, and 5 millims. in thickness. Hence its dimensions, and especially its thickness, render it unfavourable for a perfect examination of its structure under the microscope whilst in the entire condition. As only one specimen was procured, and as this was believed to be unique, no dissection was resorted to, excepting the removal of a small portion of the epidermis and external muscular tunic for microscopic examination. Hence the investigation of the structure of this Nemertine necessarily

remained an imperfect one, and the affinities of the animal amongst other Nemertines could not be determined.

The animal is leaf-like in shape, narrowing to a blunt point at the posterior extremity, and commencing abruptly at the anterior. The proboscis is protruded from the summit of a protuberance occupying the middle region of the anterior extremity. The mouth is situate on the ventral surface of the body, just posterior to the aperture for the proboscis. It is a simple aperture, with a plaited margin composed of five or six folds. It is the commencement of a short muscular tube, the œsophagus, which was seen to pass behind the most anterior prolongation of the main mesial digestive canal, but the communication of which with the latter was not traced. The digestive system stands out very conspicuously in the fresh condition of the animal, from being of the deep burnt-sienna colour already mentioned. It consists of a broad, flattened mesial canal, somewhat broadest in the middle region of the body, anteriorly ending in a bluntly terminated cæcal prolongation, and posteriorly narrowing gradually. As the posterior part of the animal was somewhat injured, it could not be determined whether the canal terminates in an anus or not.

The mesial canal receives on either side lateral tributaries in pairs, which tributaries remain simple for some distance of their horizontal course and then break up into ramifications. The most anterior pair of lateral canals is split up into by far the most ramifications. The ramifications become less and less in each pair towards the posterior extremity of the body, some of the most posterior lateral canals being simply bifurcate, and one merely enlarged at the extremity. There are thirteen pairs of lateral canals in all.

The nervous system was plainly seen in part. A pair of rounded ganglia lie on the ventral and lateral surface of the sheath of the proboscis, being a little posterior in position to the mouth. A commissure passes above the œsophagus and between it and the proboscis-sheath. From the ganglia a pair of fine simple nerve-cords pass in a curved course down to the posterior extremity, where their termination could not be ascertained. The cords cross ventrally the lateral digestive canals about the point where ramification commences. Further connexions of the ganglia could not be ascertained.

The specimen obtained was a female. A series of ovaries, consisting of pear-shaped masses of minute ova, were present, situate between each of the pairs of lateral digestive tubes, immediately external to the nerve-cord on each side. The masses of ova are contained in small cavities in the gelatinous



internal body-tissue. When pressure was exerted, the ova issued from small corresponding apertures on the ventral surface, and the small empty cavities remained. The ova were spherical, about .28 millim. in diameter, and appeared composed of fat-globules and granular matter.

The proboscis-sheath, which is wide and capacious, is very plainly seen on the dorsal aspect of the body, and dimly through the thickness of the body from the ventral aspect. It has a firm muscular attachment at its orifice; and bundles of muscular fibres (apparently retractor) are attached to it here on either side (Pl. XV. B. fig. B, 1). The proboscis itself is, when retracted, coiled up in the usual manner within its sheath, as seen in fig. D. It could unfortunately not be ascertained whether the proboscis is armed or not. It was never entirely retracted; but a small portion of it always remained exerted.

The outer surface of the body of the Nemertine is covered with a hyaline, very thin integument, which is thrown into numerous folds and wrinkles, which are so arranged along certain lines around small spaces nearly free from them as to produce on the surface of the body an appearance of a series of small polygonal areas separated by fine reticular network (fig. D). This condition of the surface was most conspicuous about the anterior part of the body; but the body was much lacerated by the meshes of the trawl, and therefore I cannot say whether the whole integument is in this condition in the fresh state or not. The folds and plaits in the integument are so sharp that they give the appearance, under the microscope, of somewhat spindle-shaped bodies with sharply pointed extremities (fig. C, 1, 2, 3). At first I supposed that these bodies were urticating organs resembling those of *Bipalium*; but on carefully teasing up a portion of the integument with fine needles, and being unable to isolate a single one, I concluded that they were mere folds. They are, however, of remarkable appearance, from their extreme abundance and the manner in which they cross each other at all angles. They are well preserved in glycerine preparations of the skin hardened in picric acid.

Beneath the integument is some granular glandular matter. Immediately beneath the integument, and in close adherence to it, is the muscular tunic, evidently the homologue of the cutaneous muscular system of *Bipalium* and other Planarians. As in these, the outermost fibres are circular in direction, the inner longitudinal.

The muscular tunic encloses the entire body. It is thin, and in the fresh condition of the animal transparent and inconspicuous, but becomes opaque when the animal is hardened

in picric acid. The inner longitudinal layer consists of stout bands of fibres running parallel to one another. The outer circular fibres are far less developed, and are not gathered into bundles, but cross one another slightly obliquely in their transverse course, forming a slight meshwork over the longitudinal fibres.

Beneath the muscular tunic and between its meshes the body mass is filled up with a gelatinous hyaline structureless matter, imbedded in which lie the viscera and the muscles attached about the orifice of the sheath of the proboscis. Internal muscles, except those referred to, were not observed.

No eyes or other sense-organs were found; and ciliated sacs were not seen.

From the circumstance of the only specimen of *Pelagonemertes* having been much lacerated, and from the animal not having been dissected, it will of course require further examination. In the specimen as procured there was a deep constriction of the body at about the junction of the first with the second fourth of its length. This, it appeared pretty evidently, had been caused by the meshes of the net. The posterior extremity was somewhat injured, and its form may not be quite correctly given. Ciliated sacs may be present; and the structure of the proboscis might throw light on the affinities of the animal.

The form of the digestive system is the most remarkable feature about *Pelagonemertes*, in its close resemblance to that of *Dendroceala*. In other respects *Pelagonemertes* is thoroughly Nemertine in structure, being merely modified for pelagic existence. It is remarkable that the gelatinous hyaline mass of the body is not tegumental in character, but apparently homogeneous with internal structures.

The occurrence of a peculiar burnt-sienna colour in many very different pelagic animals is remarkable. With many the colouring may be explained as protective resemblance to the oceanic seaweeds. For its occurrence in others, such as *Salpa* and *Pelagonemertes*, in an otherwise hyaline body, there may be some common cause, possibly also protective.

Diagnosis of the Genus *Pelagonemertes*, H. N. M.: *Body leaf-shaped, gelatinous, hyaline. The anterior extremity of the body broad and abrupt, the posterior narrowed to a point. The digestive canal with thirteen pairs of lateral ramifications, as in Dendroceala. Integument thin and hyaline, with a thin muscular tunic immediately beneath it, consisting of external circular and internal longitudinal fibres. The animal free-swimming, oceanic.*

## EXPLANATION OF PLATE XV. B.

- Fig. A.* *Pelagonemertes Rollestoni*, from the ventral surface.  $\times 2$  diameters.  
1, mouth, with oesophagus; 2, partly protruded proboscis;  
3, nerve-ganglia; 4, nerve-cords; 5, ovaries; 6, digestive canal.  
The sheath of the proboscis is seen through the body lying behind the digestive canal.
- Fig. B.* Sketch of the proboscis-sheath and contained retracted proboscis, from the dorsal aspect: 1, retractor muscles inserted into the commencement of the sheath.
- Fig. C.* 1, one of the polygonal areas, enlarged, showing the wrinkles of integument producing the appearance; 2, peculiar appearance of some of the folds of the integument.
- Fig. D.* Reticular appearance of the integument observed in certain parts of the body. Natural size.

XXI.—*Submarine-Cable Fauna.* By J. GWYN JEFFREYS, LL.D., F.R.S., and the Rev. A. M. NORMAN, M.A.

[Plate XII.]

A NOVEL and unusual method of collecting specimens of the marine Invertebrate fauna is by means of the telegraph-cables which are laid down along so many of the great ocean highways. These cables occasionally need repairs, and must be taken up for that purpose. An opportunity has lately occurred, through the kindness of Sir James Anderson, of observing the animals which were found attached to the Falmouth-and-Lisbon cable, laid in June 1870, and taken up last autumn for repairs between N. lat.  $47^{\circ} 58'$  and  $47^{\circ} 35'$ , and in W. long.  $7^{\circ} 6'$ , at depths ranging from 89 to 205 fathoms on the edge of soundings; bottom sandy. Such depths are now not considered great; but the ground seems to have been hitherto unexplored by the dredge. The accuracy of the communication made by Sir James Anderson is unquestionable, and differs in that respect from the information which misled M. Alphonse Milne-Edwards, when he published a list of the animals attached to a cable which was taken up several years ago between Cagliari and Bône.

The Mollusca thus procured are interesting only for the sake of locality; they will be noticed by Mr. Jeffreys. An account of the other Invertebrates, including some new forms, will be given by Mr. Norman.

## Part I. MOLLUSCA. By J. GWYN JEFFREYS.

## BRACHIOPODA.

*Terebratula caput-serpentis*, Linné: a small valve.

## CONCHIFERA.

*Anomia ephippium*, L., vars. *squamula* and *aculeata*: living.  
*Ostrea cochlear*, Poli: living, and moulded on the cable.

This may possibly be a variety of the polymorphous *O. edulis*, owing its peculiar shape and comparative absence of lamination to its remaining attached to corals and other cylindrical substances. I think *O. rosacea*, Deshayes, ought to be united with *O. cochlear*, as it differs only in having a brighter colour.

*Pecten opercularis*, L.: living.

— *similis*, Laskey: valves.

*Lima subauriculata*, Montagu: valves.

— *Loscombi*, Turton: a fragment.

*Avicula hirundo*, L.: living and attached to *Sertularia*.

*Mytilus phaseolinus*, Philippi: a valve.

*Kellia suborbicularis*, Mont.: living.

*Axinus cycladius*, S. Wood: a small valve.

*Cardium minimum*, Ph.: a fragment.

*Astarte triangularis*, Mont.: valves; having the inner margin notched or plain, irrespective of size and apparent age.

*Circe minima*, Mont.: young, one living.

*Venus ovata*, Pennant: valves.

*Tellina pusilla*, Ph.: a valve.

*Mactra solida*, L., var. *elliptica*: young, valves only.

## GASTROPODA.

*Cyclostrema nitens*, Ph.: dead.

*Trochus millegranus*, Ph.: dead, young.

*Rissoa soluta*, Ph.: dead.

*Triforis perversa*, L.: living and dead, young.

## PTEROPODA.

*Spirialis retroversus*, Fleming, var. *Jeffreysi*: dead.

## Part II. CRUSTACEA &amp;c. By the Rev. A. M. NORMAN.

## CRUSTACEA.

*Ebalia* —?: small fragment of carapace, apparently *E. tuberosa*, Penn.

- Galathea* —?: fragment of carapace, I think *G. dispersa*, Bate.
- Amphithopsis latipes* (Sars) = *Calliope Ossiani* and *C. Fingalli*, B. & W.: abundant. Sars's specific name has precedence of those of Bate and Westwood, whose *C. Ossiani* and *C. Fingalli* are undoubtedly but one species. The late Axel Boeck \* has placed this Amphipod in his genus *Amphithopsis*, separating it from *C. leviuscula*, which remains the type of the genus *Calliopius*, Lilljeborg (= *Calliope*, B. & W.).
- Gammaropsis erythrophthalmus*, Lilljeborg, = *Eurystheus erythrophthalmus*, B. & W.: one specimen.
- Probolium* (= *Montagua*, Bate): fragment, too imperfect for identification.
- Ægina phasma* (Montagu) = *Protella phasma*, Bate.
- Munna*: fragment.
- Loxococoncha multifora* (Norman).
- Cytheropteron nodosum*, Brady.
- Schlerochilus contortus* (Norman).
- Paradoxostoma variabile* (Baird).
- *ensiforme*, Brady.

#### POLYZOA.

- Diastopora obelia* (Fleming).
- Idmonea atlantica*, Forbes.
- Salicornaria farciminoidea* (Ellis & Sol.).
- Hippothoa catenularia* (Jameson).
- *divaricata*, Lamx. The typical form.
- *divaricata*, var. *carinata*, Norman. Pl. XII. figs. 4-7.
- A remarkable form, procured from this source, and which I have also dredged in Birterbuy Bay, is worthy of a name, and is figured (Pl. XII. figs. 4-7). It has all the cells, as well as the intercellular tubules, strongly carinated, and

\* The death of this able Scandinavian naturalist at an early age is a great loss to science. His contributions to the study of the Crustacea Amphipoda and Copepoda are all most valuable. The prodromus ('Crustacea Amphipoda borealia et arctica') which he published in 1870 marks a new starting-point in the investigation of this subclass, and contains by far the most scientific arrangement of the sessile-eyed Crustacea which has as yet appeared. The first part of his larger work, 'De Skandinaviske og Arktiske Amphipoder,' 1872, raised hopes of a most complete monograph on the subject on which it treats; but death has stepped in to rob us of the fulfilment of those hopes. Herr Axel Boeck's executors inform me that the MS. and drawings will be, it is hoped, capable of arrangement so as to allow the issue of a second part of this Monograph; but although a mass of other drawings remain, there are not the MS. or notes to enable them to be utilized.

thus presents as strongly marked features as many of the allied so-called species of *Hippothoa*.

- Eschara rosacea*, Busk.  
*Lepralia ventricosa*, Hassall.  
 — *microstoma*, Norman.  
 — *ciliata* (Linn.).  
 — *innominata*, Couch.  
 — *Brongniartii* (Aud.).

#### ECHINODERMATA.

- Antedon rosaceus* (Linck) : fragment.  
*Echinocyamus angulosus*, Leske.

#### HYDROZOA.

- Eudendrium rameum*, Pallas.

#### Genus ACRYPTOLARIA, Norman, n. g.

Zoophyte ramose, irregularly branched, branches composed of several tubes; hydrothecæ rather distant, subspirally or alternately arranged, tubular, not contracted at the base and prolonged into the branch itself; mouth somewhat patulous.

*Acryptolaria exserta* (Busk), = *Cryptolaria exserta*, Busk, Quart. Journ. Micr. Sci. vol. vi. (1858), p. 130, pl. xix. fig. 3. Pl. XII. figs. 1 & 2.

In the fifth volume of the 'Quart. Journ. Micr. Sci.' p. 173, pl. xvi., Busk established a genus *Cryptolaria* for the reception of a New-Zealand Hydrozoon, which had the peculiarity of having the "cells completely immersed in a cylindrical poly-pidom composed of numerous tubes." In the following year he described another Hydroid from Madeira under the name *Cryptolaria exserta*; but this species was devoid of the very characters on which the genus *Cryptolaria* had been established, the hydrothecæ being much exserted, and standing out at a considerable angle from the stem. Many specimens of this Madeiran form are among the cable-scrapings; and they agree in every respect with Busk's description and figures, except that they are much less regularly branched than is represented in his plate xix. fig. 3. It is impossible that this species can remain in the same genus with *C. prima*; and I therefore constitute a new genus, of which it will be the type. It seems to find its nearest relation in *Grammaria abietina* (Sars), a species which I cannot think Mr. Hincks has done right in placing in the genus *Salucia* of Lamouroux, the type of which has

the hydrothecæ in regular verticils, and the branchlets contracted in a very remarkable manner at their junction with the branches.

Genus SCAPUS, Norman, n. g.

Zoophyte in the form of a spongy mass rolled in cylindrical form round the stems of branching Hydrozoa (*Acryptolaria*), and consisting of a series of somewhat closely packed subquadrate hydrothecæ, closed in above, except at the centre, where the hydrotheca projected in the form of a short, simple, cylindrical horny tube.

*Scapus tubulifer*, Norman, n. sp. Pl. XII. fig. 1, a, & fig. 3.

Zoophyte growing in little roll-like masses round the larger stems of *Acryptolaria exserta* (Busk), almost every specimen of which was the bearer of this parasitic species, though none of the other zoophytes procured at the same time and place showed a vestige of it. The roll-like mass has a soft spongy character, the external crust being harder. It consists of a large number of hydrothecæ, which, on a section being made, prove to be subquadrate in form, and packed closely together without any interspaces; the hydrotheca is closed in above except at the centre, where it is raised in the form of a short tubular orifice, rising from the mass of the hydrozoary; this tube is often slightly, but never much bent.

At first sight this species bears a strong resemblance to *Coppinia arcta*, from which, however, we at once know it by the more elongated and delicate character of the rolls and by the much shorter tubuli. In organic structure, however, the two species are very distinct from each other. In *Coppinia* the basal mass consists of chitinous cells rendered polygonal by mutual pressure, these cells are the gonothecæ; while the slender-tubed hydrothecæ pass through the mass to the base of the hydrozoary, and are of equal diameter from the base to their free extremities (see a paper on the structure of *Coppinia* by Allman, Brit. Assoc. Report, 1868, p. 87, published subsequently to Hincks's work). In *Scapus* the basal mass consists of the hydrothecæ, which are bottle-shaped, expanded below and forming the mass, and contracted above into narrow projecting tubes.

*Sertularella polyzonias* (Linn.).

— *Gayi* (Lamx.).

*Diphasia pinaster* (Ellis & Sol.).

— *alata* (Hincks).

*Thuiaria articulata* (Pallas).

*Aglaophenia tubulifera* (Hincks).

— *myriophyllum* (Linn.).

#### FORAMINIFERA.

*Cornuspira foliacea*, Philippi: the form *involvens*.

*Triloculina trigonula*, forma *angulata*, Karrer, Sitzungsab. d. k. Akad. d. W. math.-naturw. Cl. Bd. iv. Abth. 1, 1867, pl. ii. fig. 6. The only *Triloculina* found seems referable to the *angulata* of Karrer, which is certainly not worth distinguishing by a name, but is so far interesting that it is a representative near our shores of a *group* of so-called species which have received names from D'Orbigny, Reuss, Karrer, &c.

*Quinqueloculina subrotunda* (Montagu).

*Valvulina conica*, D'Orb.

*Lagena Lyellii*, Seguenza. Mr. H. B. Brady figures this form, Ann. & Mag. Nat. Hist. ser. 4, vol. vi. pl. xi. fig. 7.

It is undoubtedly nothing more than a separated single cell of a form of *Nodosaria scalaris*, Batsch. I have a series which completely proves this statement.

— *marginata*, W. & J.

*Nodosaria scalaris*, Batsch.

*Cristellaria rotulata*, Lamk.

*Polymorphina lactea*, W. & J.

— *compressa*, D'Orb.

*Uvigerina angulosa*, Will.

— *irregularis*, H. B. Brady, Nat. Hist. Trans. Northumb. and Durham, vol. i. (1867), p. 100, pl. xii. fig. 5. A single and not well-marked specimen has been submitted to Mr. H. B. Brady, who has confirmed my opinion in referring it to this form.

*Orbulina universa*, D'Orb.

*Globigerina bulloides*, D'Orb.

— *inflata*, D'Orb. Foram. Canar. p. 134, pl. ii. figs. 7-9; Parker and Jones, Phil. Trans. 1865, p. 367, pl. xvi. figs. 16 & 17. Now first recorded as occurring so near our shores; but I have previously found it abundantly in sand from 112 fathoms dredged, in Mr. Jeffreys's yacht 'The Osprey' in 1870, 30 miles west of Valentia Island.

*Textularia sagittula*, DeFrance.

— *pygmæa*, D'Orb.

— *abbreviata*, D'Orb. Foram. Foss. Vienna, p. 249, pl. xv. figs. 7-12; Parker and Jones, Phil. Trans. 1865, p. 369, pl. xvii. fig. 76.

— *agglutinans*, D'Orb. Foram. Cuba, p. 144, pl. i. figs. 17



- & 18; Parker and Jones, Phil. Trans. 1865, p. 369, pl. xv fig. 21. I have previously found both this and the last species in the very fine collection of British Foraminifera bequeathed to me by my late friend Mr. E. Waller; the specimens are from off Valentia Island. *T. agglutinans* I have also from my Shetland dredgings.
- Bulimina Buchiana*, D'Orb. Foram. Foss. Vienna, p. 186, pl. xi. figs. 15-18; Parker and Jones, Phil. Trans. 1865, p. 374, pl. xvii. fig. 71: abundant. This strongly characterized species is also in the Waller collection, from 112 fathoms, off Valentia.
- *punctata*, D'Orb.
- Discorbina globularis*, D'Orb.
- Planorbulina Haidingerii*, D'Orb.
- Truncatulina lobatula*, Walker.
- *refulgens*, Montfort.
- Planulina ariminensis*, D'Orb.; Parker, Jones, and Brady, Ann. & Mag. Nat. Hist. ser. 4, vol. viii. pl. xii. fig. 131. Several specimens of this highly interesting Mediterranean form.
- Anomalina coronata*, Parker & Jones.
- Pulvinulina repanda*, F. & M.
- *elegans*, D'Orb.
- *Micheliniana*, D'Orb. Mém. Soc. Géol. de France, vol. iv. pl. iii. figs. 1-3; Parker and Jones, Phil. Trans. 1865, p. 369, pl. xiv. fig. 16, & pl. xvi. figs. 41-43. British examples of this very gibbous *Pulvinulina* were previously in my collection from Shetland and also Valentia (Waller's collection).
- *canariensis*, D'Orb. Foram. Canar. pl. i. figs. 34-36; Parker and Jones, Phil. Trans. 1865, p. 395, pl. xvi. figs. 47-49.
- *Menardii*, D'Orb. Modèles, no. 10; Parker and Jones, Phil. Trans. 1865, p. 394, pl. xvi. figs. 35-37.
- Rotalina orbicularis*, D'Orb.
- Polytrema miniaceum*, Linn., = *Millepora miniacea*, Linn., 1789, Syst. Nat. edit. 12 (Gmelin), vi. p. 3784, = *Polytrema corallina*, Risso, Hist. Nat. de l'Europe Mérid. p. 340, pl. v. figs. 45, 46; *Millepora rubra*, Lamk. ii. p. 202. no. 8; *Polytrema rubra*, Carpenter, Introd. Study Foram. p. 235, pl. xiii. figs. 18-20. A young specimen growing on a valve of *Pecten*. It is very interesting finding this remarkable Mediterranean Foraminifer so near our coast. The genus *Polytrema* was established by Risso, not by Blainville, who is credited with it by Carpenter.
- Operculina ammonoides*, Gron.

## PORIFERA.

Small fragments of a sponge occurred on the stems of a zoophyte. Not recognizing it, I forwarded it to Dr. Bowerbank, who pronounced it new, and has characterized it as below. There was also a mass of siliceous root-fibres, reminding one strongly of those of *Holtenia Carpenteri*; but they are not referable to that species, inasmuch as there were no hamate spined spicules (*vide* Thomson's plate lxviii. fig. 5), and the simple spicules were of two sizes—the one much larger than those of *H. Carpenteri*, the other very much more slender. I am not able, therefore, to refer this "beard" to any known sponge. I should add, however, that Dr. Bowerbank thinks they belong to *Holtenia*; but I cannot agree with him, for the reasons I have stated, in thinking so.

*"Isodictya funalis*, Bowerbank, n. sp.

"Sponge massive, sessile. Surface smooth, but uneven. Oscula simple, dispersed, minute. Pores inconspicuous. Dermal membrane pellucid, spiculous; tension-spicula acerate, slender, subfasciculate, rather few in number; retentive spicula bi- and tridentate equianchorate, rather few in number, and rarely palmato-tridentate equianchorate; also simple and contort bihamate spicula, minute and very slender, rather few in number. Skeleton: spicula acuate, stout, rather short, basally incipiently spinous; primary lines tri- or quadrispiculous, rarely more; secondary lines mostly unispiculous, rarely more than bispiculous. Interstitial membranes sparingly spiculous; spicula same as those of the dermal membrane.

"Colour, in the dried state, milk-white.

"*Hab.* On one of the Atlantic cables, 150 miles from the Land's End (*Sir James Anderson*).

"Examined in the dried state."

## EXPLANATION OF PLATE XII.

*Fig. 1.* *Acryptolaria exserta*, Busk, with *Scapus tubulifer*, Norman, parasitic at *a*: natural size.

*Fig. 2.* A portion of *Acryptolaria exserta*, magnified.

*Fig. 3.* A portion of the surface of *Scapus tubulifer*, Norman, magnified.

*Figs. 4-7.* *Hippothoa divaricata*, var. *carinata*, Norman, magnified.

XXII.—*Descriptions of new Species of Polyzoa from the Lower and Upper Silurian Rocks of North America.* By H. ALLEYNE NICHOLSON, M.D., D.Sc., F.R.S.E., Professor of Biology in the Durham University College of Physical Science, Newcastle-on-Tyne.

[Plate XIV.]

HAVING in a former communication described the species of *Alecto* and *Hippothoa* which have come under my notice as occurring in the Cincinnati Group (Lower Silurian) of Ohio, I have now to describe from the same formation several species of *Ptilodictya* and one of *Ceramopora*, which I have been able to determine, from the collections submitted to me by Mr. U. P. James and Prof. Edward Orton, and all of which appear to be new. I have also an interesting species of *Fenestella* to describe, from the Upper Silurian (Guelph division of the Niagara formation) of the State of Ohio.

1. *Ptilodictya falciformis*, Nich. Pl. XIV. figs. 1-1 b.

Polyzoary consisting of a single, unbranched, or slightly branched, elongated, flattened and two-edged frond, the form of which is curved or falciform, and which gradually expands from a pointed base till it reaches a width of two lines within a distance of less than half an inch above the base. The total length may exceed two inches; but the width, in typical examples, rarely exceeds two and a half lines. The transverse section is acutely elliptical, the thickness in the middle not exceeding half a line; and the flat faces of the frond are very gently curved and not angulated. A central laminar axis, though often undemonstrable, can sometimes be clearly shown to exist. The edges of the frond are thin and sharp, formed by a narrow band, which is marked with longitudinal or slightly oblique striæ and by the apertures of minute imperfect cells. Both sides of the frond are celluliferous, the cells being apparently perpendicular to the surface, and being arranged in intersecting diagonal lines, which form angles of about  $30^\circ$  with the sides of the frond, and thus cut one another at about  $60^\circ$ . The mouths of the cells are oval or somewhat diamond-shaped, their long axis coinciding with that of the frond, alternately placed in contiguous rows, about eight in the space of one line measured diagonally; the outermost rows very slightly smaller than the others. Walls of the cells moderately thick; no surface-granulations, tubercles, spines, or elevated lines. The mouths of the cells parallel with the general surface, neither lip being especially prominent, and the plane of the aperture not being oblique.

As a general rule the polyzoary is simple, unbranched, and falceiform. I have seen, however, in the fine collection of Mr. Dyer, of Cincinnati, some specimens in which the frond bifurcates at its distal extremity, and at least one example in which it splits into three divisions. I have also seen examples of what may probably prove to be a distinct species, in which the frond is very much wider than is normally the case.

This beautiful species is allied to *Ptilodictya (Escharopora) recta*, Hall, on the one hand, and to *P. lanceolata*, Goldf., *P. gladiola*, Billings, and *P. sulcata*, Billings, on the other hand. The specimens from which the above description is taken were sent to me with the label of *Escharopora recta* attached to them; and at first sight they certainly closely resemble this species, especially in the disposition of the cells in intersecting diagonals of great regularity. It is certain, however, that they are distinct from Hall's species—the chief differences consisting in the fact that the frond of *P. falceiformis* is greatly flattened, so that the transverse section is acutely elliptical instead of being "cylindrical or subcylindrical," whilst the edges are sharp and non-celluliferous, and the entire frond is regularly curved and sabre-shaped instead of being straight. Hall states that *Escharopora recta* is not branched, but possesses root-like processes. Judging, however, from his figures, it would seem probable that his specimens have been drawn and described in an inverted position, and that this form is in reality dichotomously branched (Pal. N. Y. vol. i. pl. xxvi. fig. 1 a).

From *Ptilodictya lanceolata*, Goldf. (Petref. pl. xxxvii. fig. 2), the present species is readily distinguished, more especially by the disposition of the cells, which are in regularly intersecting diagonal lines; whereas in the former there is a central series of longitudinally arranged cells, flanked on each side by diagonal rows directed like the barbs of a feather.

With *Ptilodictya gladiola*, Billings (Cat. Sil. Foss. of Anticosti, p. 10), our species agrees in the shape of the frond; but it is proportionally twice as wide, whilst the cells are oval instead of being rectangular or oblong, and are disposed in decussating diagonals instead of in regular longitudinal lines as in the former.

Lastly, *Ptilodictya sulcata*, Billings (*loc. cit.* p. 35), whilst resembling *P. falceiformis* in shape, is distinguished by the nearly square cells with intercellular sulci, and by the fact that the cells are arranged in longitudinal lines.

*Locality and Formation.*—Not uncommon in the Cincinnati Group, near Cincinnati, Ohio. Collected by Mr. U. P. James.

2. *Ptilodictya emacerata*, Nich. Pl. XIV. figs. 2-2 b.

Polyzoary consisting of minute, narrow, linear fronds, which branch dichotomously, and have the form of a much flattened, acutely pointed ellipse in transverse section. Width one third of a line; length of largest specimen observed two lines. Cells elliptical, their long axes corresponding with that of the branches, about six or seven in the space of one line measured longitudinally. There are four, five, or rarely six rows of cells in the frond. When four rows of cells are present, two of these (in the centre) are longitudinal, and one row on each side is composed of cells directed in an obliquely ascending manner. When there are five rows, as is most commonly the case, the three central ones are longitudinal and a lateral row on each side is oblique. When there are six rows, two central ones are longitudinal and two on each side oblique. The cell-mouths are much longer than wide, and each row is separated from the next by an elevated line. The lateral margin of the frond on each side forms an obtuse non-celluliferous edge, the width of which is so small that it cannot always be detected. A central axis was not clearly determined, but is doubtless present.

The only previously recorded species of the genus to which *Ptilodictya emacerata* presents any close resemblance is *P. fragilis*, Billings, from strata of the same age in Anticosti (Cat. Sil. Foss. of Anticosti, p. 9). Our species, however, is distinguished from the latter by its uniformly more minute dimensions, the smaller number of rows of cells in the frond, and the possession in general of no more than a single row of oblique cells on each side. *P. fragilis*, on the other hand, has a width of from two thirds of a line to one line, with from eight to ten rows of cells, and two or three rows of oblique marginal cells on each side. It is possible our form is only a variety of *P. fragilis*; but in the absence of figures of the latter, and in the face of the differences above mentioned, I think it safest to regard *P. emacerata* as a distinct species.

*Locality and Formation.*—Cincinnati Group, near Cincinnati, Ohio. Collected by Mr. U. P. James.

3. *Ptilodictya flagellum*, Nich. Pl. XIV. figs. 3-3 b.

Polyzoary consisting of a single, narrow, unbranched, two-edged, flattened frond, which has an acutely elliptical section. The frond commences at an attenuated base, and gradually expands till a width of one line is reached, the total length of the

only specimen examined being eight lines. The general form of the frond is falciform, but towards the base it is alternately bent from side to side in a flexuous manner. The cells are arranged in longitudinal rows, about ten rows in the space of one line, the cells of contiguous rows alternating with one another. The cell-mouths, where most perfect, are narrow and long-oval—where worn, subcircular; and the rows of cells are separated by strongly elevated longitudinal ridges. The non-celluliferous margins of the frond are inconspicuous; and the central axis, though doubtless present, was not clearly determined.

This species most nearly resembles *Ptilodictya gladiola*, Billings, from which it is distinguished by its much smaller size and less width, and by its flexuous form. From *P. falciformis*, Nich., it is separated not only by the above characters, but also by the longitudinal arrangement of the cells.

*Locality and Formation.*—Cincinnati Group, Lebanon, Ohio, immediately below the horizon of *Streptelasma corniculum*. Collected by Prof. Edward Orton and Mr. W. Bean.

#### 4. *Ptilodictya* (?) *arctipora*, Nich. Pl. XIV. figs. 4-4b.

Polyzoary forming a cylindrical, slightly branched frond, which is not sharp-edged, exhibits no non-celluliferous borders, and shows no traces of a central laminar axis. Cells arranged in obscurely longitudinal alternating rows, apparently perpendicular to the surface, and radiating in all directions from an imaginary axis. Cell-mouths very much compressed, much longer than wide, expanded below and attenuated superiorly, where they are often somewhat twisted and bent. Upon the whole, the cells are pyriform in shape, with their narrow ends directed upwards, about eight occupying the space of one line measured vertically, and twelve the same space measured diagonally. The cells are not always in contact, especially in their upper portion; and their borders are always distinctly marked off by impressed lines; but they are not arranged between elevated longitudinal ridges. The margins of the cells are very thick and conspicuous, not granulated, tuberculated, or spinigerous.

The best-preserved fragment examined had a length of eight and a half lines, dividing at its summit into two branches, its diameter being rather more than one third of a line.

From its cylindrical form, and the absence of a laminar axis or of non-poriferous margins, it would seem certain that this singular form is not a *Ptilodictya*; but I am at a loss to know where it should properly be placed, its extreme minuteness

rendering its generic affinities very uncertain, owing to the impossibility of making out the details of its internal structure. It has, however, some affinity with *Ptilodictya* (?) *varipora*, Hall, from the Clinton Group; and I have therefore referred it provisionally to this genus.

*Locality and Formation.*—Cincinnati Group, near Cincinnati, Ohio. Collected by Mr. U. P. James.

5. *Ptilodictya fenestelliformis*, Nich. Pl. XIV. figs. 5-5 b.

Polyzoary palmate or subpalmate towards the base, dividing distally into small branches. Basal expansion and branches flattened and sharp-edged, the branches being acutely elliptical in cross section, and about three fourths of a line in thickness centrally. Cells covering the whole surface on both sides, with the exception of the sharp lateral margins, which are non-celluliferous, as well as of certain non-poriferous areas to be subsequently noticed. The cells on the two aspects of the flattened frond respectively have their bases separated by a thin laminar axis. The cells in the middle of the frond are about three eighths of a line in height, gradually diminishing towards the margins. Cell-mouths ovate, slightly longer than broad, arranged in longitudinal rows, alternate or subalternate in contiguous rows; about five cells in one line measured longitudinally, and six in the same space measured diagonally. The longitudinal spaces between the rows of cells are broad and slightly elevated, and are faintly striated longitudinally or obscurely punctate. On the other hand, the spaces between the *ends* of the cells are very much narrower; and the surface thus closely resembles that of a small *Fenestella*—the cell-mouths looking like “fenestrules,” the longitudinal interspaces between the cells representing the “interstices,” and the narrow spaces between the ends of the cells corresponding with the “dissepiments.” The only specimens examined exhibit numerous, apparently solid, rounded or stellate areolæ, of an average diameter of two thirds of a line, which are not occupied by cells, but which exhibit an obscurely pitted surface.

In its superficial characters this form might readily be taken for a *Fenestella*, whilst the character last mentioned gives it somewhat the aspect of certain species of *Chatetes* (*Monticulipora*). Its internal structure, however, proves it beyond all question to be a genuine *Ptilodictya*; and I am not acquainted with any other species of this genus with which it could be confounded.

*Locality and Formation.*—Cincinnati Group, near Cincinnati, Ohio. Collected by Mr. U. P. James.

6. *Fenestella nervata*, Nich. Pl. XIV. figs. 6, 6 a.

Fronde fan-shaped (?), composed of narrow, closely approximated branches, about four or five of which occupy the space of one line. On the non-celluliferous side of the frond are two strong, slightly diverging, rounded ribs, about half a line in diameter, like the midribs of a multicostate leaf. From the sides of these ribs the branches spring obliquely, being directed in opposite directions on opposite sides of the rib, with which they make a very acute angle ( $10^{\circ}$  or less). Fenestrules long and narrow, nearly twice as long as wide, about three in the space of one line measured vertically, and about five in the same space measured transversely. For the most part the fenestrules do not alternate in contiguous rows, but are placed opposite one another. The narrow rounded dissepiments are thus also placed nearly or quite opposite to one another. Branches faintly striated in a longitudinal direction. Celluliferous side unknown.

The only example of this species that I have seen is imperfect, and the ribs from which the branches rise are placed two lines apart near the base, and four lines apart near the summit. It would seem most probable that the ribs sprung from a common root, and that there were many of them in the perfect frond. The species is distinguished not only by the possession of these ribs, but also by the long narrow fenestrules, which are not placed alternately, but so disposed that the dissepiments connecting contiguous branches become opposite or subopposite.

*Locality and Formation.*—Summit of the Niagara Formation (in beds probably the equivalent of the Guelph Formation of Canada), Cedarville, Southern Ohio. Collected by Prof. Edward Orton.

7. *Ceramopora ohioensis*, Nich. Pl. XIV. figs. 7-7 d.

Polyzoary incrusting, forming thin expansions attached to the surface of Brachiopods and Corals, and consisting, typically at any rate, of a single layer of oblique cells. Cells arranged in intersecting diagonal lines, and disposed in a somewhat concentric manner round more or fewer central points; their upper walls thin and arched; the cell-mouths oblique and, when most perfect, semicircular in shape. About eight cells in the space of one line.

Such are the appearances presented by this fossil when quite perfect; and its examination in this condition leaves little doubt as to the propriety of placing it in Hall's genus



*Ceramopora*. Worn examples, however, exhibit very different characters; and when the entire original surface has been abraded, it is sometimes difficult or impossible to determine whether or not one is dealing with this or some entirely different form.

When slightly worn, the appearances shown in fig. 7 *a* are exhibited. The delicate front wall of the cell has now disappeared; and the cavity of the cell appears to be divided into two distinct compartments, a larger and a smaller, both of a somewhat triangular shape, by an oblique internal septum. Besides, other smaller cavities appear in the walls separating the different cells.

When more deeply worn down, or under certain conditions not clearly understood, the cells (figs. 7 *c* & 7 *d*) appear in the form of rounded or oval apertures, arranged in diagonal rows, but separated by a vast number of small rounded foramina, which appear to be the mouths of interstitial tubuli. In this condition the fossil presents much the appearance of certain species of *Chaetetes* (*Monticulipora*).

The best examples of this singular Polyzoon that I have seen, grow in the form of thin crusts, rarely exceeding one fourth of a line in thickness, upon *Strophomena alternata*, Conrad, and upon various species of *Chaetetes*. In some examples it would seem that several layers of cells are superimposed on one another; but I am not sure of the nature of these specimens. Not uncommonly the cells are concentrically disposed round a number of irregular areolæ, each of which is formed by a number of cells radiating from a central point. Young examples form circular crusts, with a slightly cupped centre, from which the cells radiate in every direction (fig. 7 *b*). Lastly, examples are not uncommon which appear to have the form of small branching stems. Some of these certainly are merely constituted by thin crusts growing upon various ramose species of *Chaetetes*. Others, however, appear to be entirely composed of the Polyzoon itself; and it is possible that these will eventually prove to be a distinct species.

*Locality and Formation*.—Cincinnati Group, near Cincinnati, Ohio. Collected by Mr. U. P. James.

#### EXPLANATION OF PLATE XIV.

- Fig. 1. *Ptilodictya falciformis*, Nich., a small example, of the natural size. 1 *a*. Transverse section of the frond, enlarged. 1 *b*. Small portion of the surface, greatly enlarged.
- Fig. 2. *Ptilodictya emacerata*, Nich., of the natural size. 2 *a*. Transverse section of the frond, enlarged. 2 *b*. Portion of the surface, greatly enlarged.

- Fig. 3.* *Ptilodictya flagellum*, Nich., of the natural size. 3*a.* Transverse section of the same, enlarged. 3*b.* Portion of the surface, enlarged.
- Fig. 4.* *Ptilodictya* (?) *arctipora*, Nich., a fragment, of the natural size. 4*a.* Portion of the same, enlarged. 4*b.* A few cells of the same, enlarged further.
- Fig. 5.* *Ptilodictya fenestelliformis*, Nich., a fragment near the base of the frond, of the natural size. 5*a.* Transverse section of the same, enlarged. 5*b.* Portion of the surface, showing one of the non-poriferous areolæ, enlarged.
- Fig. 6.* *Fenestella nervata*, Nich., a fragment, of the natural size. 6*a.* Portion of the same, enlarged.
- Fig. 7.* *Ceramopora ohioensis*, Nich., part of an incrusting specimen, greatly enlarged. 7*a.* A few cells from a worn specimen of the same, greatly enlarged. 7*b.* Portion of a young example of the same, showing the radiating growth of the cells from a central point, enlarged. 7*c* & 7*d.* Fragments of much-worn specimens of the same (?), showing numerous interstitial tubuli, enlarged.

### XXIII.—On some new exotic Sessile-eyed Crustaceans.

By the Rev. THOMAS R. R. STEBBING, M.A.

[Plate XV. A.]

I. OF the Crustaceans now to be described, the first is a small Amphipod sent to me by H. J. Carter, Esq., F.R.S., who found three specimens of it in a sponge, a branched Suberite, from the Antarctic sea, dredged up by Sir J. Ross in S. lat. about  $77\frac{1}{2}^{\circ}$  and E. long.  $175^{\circ}$ , from a depth of 300 fathoms.

Two of the specimens are about an eighth of an inch in length, the third being very much smaller. Whether the larger pair had attained their full size or not is open to question. All are of a dark-brown colour—in that respect, Mr. Carter tells me, resembling the sponge from which he took them. All were closely coiled up, with the gnathopods hidden and tail and antennæ tucked under the body. This posture, coupled with the breadth of the pereion or thorax, gave the creatures a subglobose aspect, at the first glance not a little resembling that of a folded Sphæromid. In point of fact, however, their affinities seem to be with the genus *Dexamine*, Leach. The superior antennæ have the first joint stout, the second more slender and twice as long, the third not differing from the following articulations of the flagellum. In the lower antennæ only two of the joints of the peduncle could be made out distinctly, being probably the penultimate and

antepenultimate—the former being more slender than the latter, but in length subequal both to it and to the second joint of the upper antennæ. The flagellum of the upper antennæ is longer and stouter than that of the lower.

In the first and second gnathopods the wrists and hands are hairy; the wrist in each case is about equal in length to the hand. The hand in the first gnathopods is subovate in shape, with no distinct palm, and the finger projecting rather prominently. In the second gnathopods the hand is rather larger, with a fairly defined palm, upon which the finger folds down without overlapping it. In the five following pairs of legs (the pereopoda) the fingers are all directed backwards, a character which Mr. Spence Bate notes as generally prevailing in the genus *Dexamine*. It is these five pairs of pereopoda which are the most peculiar and distinctive parts of the animal. They are all alike, with the exception of the coxal joints; and as far as could be made out, they are all equal. The thighs are well developed both in breadth and length. The metacarpal joints are also long, about equalling the wrist and hand conjointly. Long spines are attached to the postero-distal extremity of the wrist. The hands are prehensile, a much-curved finger being opposed to the outer point of an excavated palm. In the actual state of the specimens it was not, however, possible to decide whether the palm terminated in two points with a central spine, or in one point with a spine on either side. There seemed to be an additional spine within the palm close to the base of the finger. The telson is long, lanceolate, and deeply cleft. The coxal joints are figured as they appeared; but those of the first three pairs of pereopoda were not well preserved, and in a normal state are probably less irregular in shape than those which I have drawn.

The specimens have a very noticeable metallic lustre.

Unless a new genus should be thought wanting, on account of the prehensile feet of the pereopoda, *Dexamine antarctica* will be an appropriate name for this minute novelty.

II. The next species to be described, also minute and also new, comes from Algoa Bay, South Africa. It travelled to England with the same collection of sponges and Gorgonias which supplied the Arcturidæ described in the 'Annals' for August 1873. There can be little doubt that it ought to be referred to the genus *Seba*, founded by Costa for a Neapolitan species, which Mr. Spence Bate has described and figured in his British-Museum Catalogue, stating that "the descriptions of both the genus and species, as well as the figure, are taken

from a figure given in a memoir in the possession of Professor Milne-Edwards." That the first species of *Seba* should be taken on the coast of Naples, while the second comes from South Africa, suggests the reflection that there must be whole armies of sessile-eyed crustaceans yet to be discovered.

The generic characters given for *Seba* are as follows:—"Slender, smooth; antennæ long, subequal; coxæ small, four anterior deeper than the three posterior; gnathopoda uniform, subequal, chelate." The new species agrees with *Seba innominata* in all these respects, except that the antennæ (at least in my specimen, which may be a very young one) are not very long, and that the gnathopods, though agreeing in general character, are not precisely uniform. The first are shorter than the second; they have the thighs more slender, the hands broader, and the intermediate joints notably of less length. In both the infero-anterior angle of the hand is produced, so as to be equal in length to the finger. The first gnathopod is given in the figure as it and its fellow appeared in the specimen; but the reversed position of the wrist, hand, and finger, pointing forwards instead of backwards, is not likely to be the natural position in the living animal.

The last three pairs of pereiopoda differ from those of *Seba innominata* in having the thighs broad, in the last pair with a serrated edge, and in having the metacarpal joints strongly developed and overlapping the wrists. The telson is small; the caudal appendages short, the rami of the second pair extending a little beyond those of the first and third. The name proposed is *Seba Saundersii*, out of respect for W. Wilson Saunders, Esq., F.R.S., for whom the marine treasures were collected among which this little stranger, about an eighth of an inch long, reached our shores.

III. Out of the same sifting of sand and fragments which yielded the *Seba* came a tiny Isopod, only a twelfth of an inch in length, with a very striking resemblance, at first sight, to the figure of *Cymodocea armata* in Milne-Edwards's 'Histoire Naturelle des Crustacés' (pl. xxxi. fig. 16). The resemblance, however, is only one of general outline; for whereas the striking feature in the *Cymodocea* is the triangular prolongation of the seventh segment of the thorax, in the new species it is the terminal segment of the abdomen or tail which is produced beyond the caudal appendages into a large conical tooth.

The body is smooth, with scale-like markings visible under a lens over all parts of the skin. The abdomen is in two divisions, the first retaining indications of three segments sol-

dered together. The second division is nearly three times as long as the first, and for two thirds of its length is much inflated; it then becomes slightly constricted and considerably depressed. Of the caudal appendages the outer plate is much smaller than the inner both in length and breadth, and is oval in shape. The inner plate follows much the same curve along its free border; but, where it closely adjoins the tail-segment to which it is united, it has a slight concavity fitting the corresponding convexity of the tail-piece. On the underside of the animal a broad fold of this last tail-segment stretches the whole length of each side of it; beneath the narrower part of the segment the edges of these folds meet.

There is a species of *Sphæroma* (*Sphæroma Jurini*) described by Milne-Edwards from the Egyptian crustaceans of Savigny and Audouin, of which he says:—"This species appears to be very near to *Sphæroma serratum*, but is distinguished from it by the form of the last segment of the abdomen, which is prolonged backwards into an obtuse point. The external plate of the caudal appendages has its edge smooth. The length is about two lines." This, as far as it goes, might fairly suit the present species; but as nothing is said of the great difference in size between the plates of the caudal appendages, which are in consequence very unlike those of *Sphæroma serratum*, there can be little doubt that the present is a distinct species, for which I propose the name of *Sphæroma algoense*.

It is scarcely of importance to mention that both this and *Seba Saundersii* are light yellow in colour, since the colour may have faded or changed since the animals' deaths. It may be remarked, too, that some of our English species of *Sphæroma* are exceedingly variable in colour.

IV. Before closing this paper, I may observe that along with the new species some very small specimens have presented themselves of *Arcturus lineatus*, described and figured in the 'Annals' for August 1873, above referred to. The point demanding notice in reference to these young specimens is that the fourth segment of the thorax is not elongated as in adult life—a point the more interesting, because upon this character Milne-Edwards grounds a division of the genus *Arcturus* into two sections:—one containing the large *Arcturus Baffini* from Baffin's Bay, which has the segment in question not elongate; the other containing the British *Arcturus longicornis*, which has this one segment as long as all the other body-segments put together. Of these sections Goodsir made a genus *Arcturus* and a genus *Leachia*—a division obviously now inconvenient, since according to it our *Arcturus lineatus*

would belong at one time of its life to the one and at another time to the other.

EXPLANATION OF PLATE XV. A.

- Fig. 1. Dexamine antarctica.* 1 a. First gnathopod. 1 b. Second gnathopod. 1 c. Third pereopod. 1 d. Hand and finger of third pereopod, more highly magnified.  
*Fig. 2. Seba Saundersii.* 2 a. First gnathopod. 2 b. Second gnathopod. 2 c. Fifth pereopod.  
*Fig. 3. Spheroma algoense.* 3 a. Underside of tail-piece.

XXIV.—*Descriptions of some new North-American Lithobioidæ.* By ANTON STUXBERG.

1. *Lithobius monticola*, n. sp.

*Lamina cephalica* subcircularis, eadem fere latitudine ac longitudine, margine postico subrecto, setis punctisque impressis sparse prædita. *Antennæ* mediocres, articulis 20 maximam partem cylindræis, setis rigidis vestitis compositæ. *Oculi* longitudine triplo majore quam altitudine, ocellis 7-9 in 2 series longitudinales digestis. *Coxæ* pedum maxillarium secundi paris dentibus 6+6 conicis, acutiusculis, nigerrimis armatæ. *Scuta dorsualia* rugulosa, sparsissime pilosa, 2°, 4°, 6°, 7°, 9°, 11°, 13° margine postico recto, angulis posticis rectis vel rotundate rectangulis, 1°, 3°, 5°, 8°, 10°, 12°, 14° margine postico elevato sinuato, angulis parum productis, rotundate acuminatis. *Scutum ventrale* 15<sup>um</sup> fovea longitudinali profundiore, cetera omnia plana. *Pori coxales* numerosi, rotundi, in 3-4 series irregulares dispositi. *Pedes* primi paris calcaribus 2, 3, 2. *Pedum analium* articulus primus calcaribus binis, altero majore inferiore, altero minore laterali armatus. *Pedes anales* ungue singulo, calcaribus 1, 4, 3, 1-1, 4, 3, 2 armati. *Color* non manifestus.

Longitudo corporis 18 millim.

*Hab.* in Sierra Nevada (*G. Eisen*).

2. *Lithobius pusio*, n. sp.

*Lamina cephalica* subcircularis, eadem fere latitudine ac longitudine, setis minimis sparsissimis. *Antennæ* breviores, articulis 20 plerumque brevibus, crassis compositæ, ex quibus ultimus longissimus, longitudine quatuor præcedentes junctos æquans. *Oculi* ocellis 6 magnis in 2 series

(1 + 3, 2) digestis. *Coxæ* pedum maxillarium secundi paris sinu mediano lato et profundo, dentibus 5 + 5 validis nigris armatæ. *Scuta dorsualia* omnia angulis posticis rotundatis, 1°, 3°, 5°, 8°, 10°, 12°, 14° margine postico medio sinuato, 2°, 4°, 6°, 7°, 9°, 11°, 13° recto. *Scuta ventralia* plana. *Pori coxales* 2, 3, 3, 2, rotundi (♂). *Pedes* primi paris calcaribus 1, 1, 1. *Pedum analium* articulus primus calcaribus binis, majore ventrali, minore laterali armatus. *Pedes anales* longissimi, subtenuis, rigide et sparse setosi, ungue singulo, calcaribus 1, 3, 2, 0 armati. *Color* dorsii non manifestus; caput castaneum, antennarum interiore parte nigra, exterioriore pallidior; venter cum pedibus pallide griseus.

Longitudo corporis 8-9 millim., antennarum 2.5-3 millim., pedum analium 4 millim.

*Hab.* in California ad San Francisco (*G. Eisen*).

### 3. *Lithobius paradoxus*, n. sp.

*Lamina cephalica* subquadrata, latitudine paullo majore quam longitudine, margine postico elevato recto, setis magno intervallo distantibus vestita, glabra, evidentissime reticulata.

*Antennæ* magnitudine dimidiam corporis longitudinem fere æquant, articulis 20 irrigue setosis, crassiusculis, compositæ. *Oculi* longitudine fere triplo majore quam altitudine, ocellis 8 in 4 series transversales (2, 2, 2, 2) digestis. *Coxæ* pedum maxillarium secundi paris dentibus 2 + 2 armatæ.

*Scuta dorsualia* omnia angulis posticis rotundatis, 3°, 5°, 8°, 10°, 12°, 14° margine postico sinuato, 1°, 2°, 4°, 6°, 7°, 9°, 11°, 13° recto. *Scuta ventralia* plana vel convexiuscula.

*Pori coxales* 1, 2, 2, 2 rotundi (♂). *Pedes* primi paris calcaribus 1, 2, 1.

*Pedum analium* articulus primus inermis. *Pedes anales* incrassati, ungue singulo, calcaribus 1, 2, 1, 0 armati. *Color* brunneus, capite antennisque nigrioribus, scutis ventralibus cum pedibus, præsertim analibus, pallidioribus.

Longitudo corporis 11 millim., antennarum 4-4.5 millim., pedum analium 3.5 millim.

*Hab.* in California circa urbem San Pedro (*G. Eisen*).

Species processu magno piloso quarti articuli pedum analium (♂) insignis.

### 4. *Lithobius obesus*, n. sp.

*Lamina cephalica* subquadrata, eadem fere longitudine ac latitudine, margine postico subrecto, setis longis rigidis parcius

vestita. *Antennæ* breviores, tertiam partem longitudinis corporis æquantés, articulis 20 cylindraccis longe setosis compositæ, 6 interioribus longissimis, ultimo longitudine minore quam 3 præcedentibus junctis. *Oculi* ellipsoidei, longitudine duplo majore quam altitudine, ocellis 10, postico magno transverso, ellipsoideo, ceteris in 3 series digestis, ocello mediæ seriæ postico maximo, rotundo. *Coxæ* pedum maxillarium secundi paris dentibus 2+2 validis armatæ, marginibus antico-lateralibus setis 4-5 longissimis vestitæ, sinu mediano lato, haud profundo. *Scuta dorsualia* omnia angulis posticis rotundatis, 3°, 5°, 8°, 10°, 12°, 14° margine postico elevato sinuato, 1°, 2°, 4°, 6°, 7°, 9°, 11°, 13° recto, non elevato. *Scuta ventralia* omnia plana, posteriora præsertim dense pilosa. *Pori coxales* 2, 3, 3, 3 rotundi (♀). *Pedes* primi paris calcaribus 1, 2, 1. *Pedum analium* articulus primus calcari singulo laterali minore (vix visibili) armatus. *Pedes anales* breves, plus vel minus incrassati, ungue singulo, calcaribus 1, 3, 2, 1 armati. *Unguis genitalium* femineorum magnus, integer. *Color* —.

Longitudo corporis 13 millim., antennarum 5 millim., pedum analium 4 millim.

*Hab.* in California ad Sauzelito haud procul ab urbe San Francisco (*G. Eisen*). Unum tantum specimen (♀) vidimus.

##### 5. *Lithobius Kochii*, n. sp.

*Lamina cephalica* obcordata, paullo latior quam longior, pilosa.

*Antennæ* breves, tertiam partem longitudinis corporis haud multo superantes, articulis 20 cylindraccis compositæ. *Oculi* ocellis 9, in 3 series longitudinales curvatas digestis (1+3, 3, 2). *Coxæ* pedum maxillarium secundi paris dentibus 2+2 armatæ. *Scuta dorsualia* omnia angulis posticis rectis vel rotundate rectangulis, marginibus valde elevatis. *Pori coxales* 2, 3, 3, 3 rotundi (♀). *Pedes* primi paris calcaribus 0, 1, 1. *Pedum analium* articulus primus calcari singulo laterali armatus. *Pedes anales* breves, haud incrassati, longitudine antennas æquantés, unguibus binis, calcaribus 1, 3, 2, 0 armati. *Unguis genitalium* femineorum bilobus; calcarium duo paria. *Color* dorsi testaceo-brunneus.

Longitudo corporis 11 millim., antennarum et pedum analium 4 millim.

*Hab.* in California ad Sauzelito (*G. Eisen*).

##### 6. *Lithobius megaloporus*, n. sp.

*Lamina cephalica* obcordata, hirsuta, margine postico subrecto



elevato, parte antica sulco profundiore a postica sejuncta. *Antennæ* perbreves, articulis 19–20 compositæ, ex quibus ultimus longissimus, tres antecedentes junctos longitudine æquans, 2°, 3°, 8°, 9°, 10°, 14°, 15°, 16° mediocribus, ceteri latitudine duplo majore quam longitudine minimi. *Oculi* ocellis 7 magnis in 2 series (1 + 3, 3) digestis. *Coxæ* pedum maxillarium secundi paris dentibus 2 + 2—3 + 3 crassis, acumine nigris armatæ, sinu mediano lato, haud profundo. *Scuta dorsualia* 9<sup>um</sup>, 11<sup>um</sup>, 13<sup>um</sup> angulis productis, 2<sup>um</sup>, 4<sup>um</sup>, 6<sup>um</sup>, 7<sup>um</sup> margine postico recto, 1<sup>um</sup>, 9<sup>um</sup> convexo, 3<sup>um</sup>, 5<sup>um</sup>, 8<sup>um</sup>, 10<sup>um</sup>, 12<sup>um</sup>, 14<sup>um</sup> sinuato. *Scuta ventralia* omnia, præsertim marginibus, setis longis, magnis vestita, medii corporis sulco profundiore longitudinali mediano, laterali minore et brevioris, ex angulo postico laterali excurrente. *Pori coxales* 2, 2, 1, 1, 1 maximi, rotundi. *Pedes* primi paris calcaribus 1, 1, 1. *Pedum analium* articulus primus calcaribus nullis, setis 2 longioribus, altera ventrali, altera laterali armatus. *Pedes anales* perbreves, longitudinem antennarum non assequentes, incrassati, ungue singulo, calcaribus 0, 1, 1, 0 armati. *Color* dorsi testaceo-brunneus, laminis ventralibus pedibusque pallidioribus.

Longitudo corporis 12 millim., antennarum 4 millim., pedum analium 2·5 millim.

*Hab.* in California ad San Francisco (*G. Eisen*).

Species ab omnibus huc usque cognitæ diversa; poris coxalibus in pedum paribus 11°, 12°, 13°, 14°, 15° locatis.

#### 7. *Lithobius eucnemis*, n. sp.

*Lamina cephalica* obcordata, fere æque longa ac lata. *Antennæ* longiores, dimidiam partem corporis longitudinis fere assequentes, articulis 20 (24) cylindraceis, rigide pilosis compositæ. *Oculi* ocellis 16 in 4 series curvatas digestis (1 + 4, 4, 4, 3). *Coxæ* pedum maxillarium secundi paris dentibus 3 + 3 armatæ. *Scuta dorsualia* 9<sup>um</sup> angulis rotundatis, 11<sup>um</sup> et 13<sup>um</sup> angulis parum productis. *Pori coxales* 4, 5, 5, 4 rotundi. *Pedes* primi paris calcaribus 1, 2, 1. *Pedum analium* articulus primus calcari singulo laterali armatus. *Pedes anales* breviores, parum incrassati, unguibus binis, calcaribus 1, 3, 3, 1. *Unguis genitalium* femineorum bilobus; calcarium duo paria, exterius majus. *Color* castaneus vel brunneus.

Longitudo corporis 13·5 millim., antennarum 6 millim., pedum analium 5 millim.

*Hab.* in Mount Lebanon (*G. Eisen*).

8. *Lithobius Saussurei*, n. sp.

*Lamina cephalica* obcordata, fere æque longa ac lata, lateribus semicirculariter rotundatis, lævis, pilis sparsis vestita. *Antennæ* sat longæ, corporis dimidiam longitudinem haud assequentes, articulis 27 parce setosis, ultimo penultimum longitudine haud multo superante, compositæ. *Oculi* ——. *Coxæ* pedum maxillarium secundi paris dentibus 5+5 nigerrimis, brevibus, validis armatæ, sinu mediano subprofundo. *Scuta dorsualia* anteriora levius, posteriora manifestius rugulosa, at non granulata, subglabra, 9<sup>um</sup>, 11<sup>um</sup>, 13<sup>um</sup> angulis productis, 7<sup>um</sup> margine postico medio profunde sinuato. *Pori coxales* 5, 6, 7, 6 magni, subrotundi. *Pedes* primi paris calcaribus 2, 3, 2. *Pedum analium* articulus primus calcari singulo, laterali armatus. *Pedes anales* breves, sat inflati, unguibus binis, calcaribus 1, 3, 3, 1 armati. *Unguis genitalium* femineorum obsolete trilobus, lobo mediano laterales haud multo superante; calcarium duo paria. *Color* castaneus vel brunneus.

Longitudo corporis 23 millim., antennarum 9 millim., pedum analium 6-7 millim.

*Hab.* in Mexico circa urbem Orizaba (*H. de Saussure*). Unum tantum specimen (♀) vidimus.

Upsala, February 10, 1875.

XXV.—*Do Varieties wear out, or tend to wear out?*

By Professor ASA GRAY\*.

THIS question has been argued from time to time for more than half a century, and is far from being settled yet. Indeed it is not to be settled either way so easily as is sometimes thought. The result of a prolonged and rather lively discussion of the topic about forty years ago in England, in which Lindley bore a leading part on the negative side, was, if we rightly remember, that the nays had the best of the argument. The deniers could fairly well explain away the facts adduced by the other side, and evade the force of the reasons then assigned to prove that varieties were bound to die out in the course of time. But if the case were fully reargued now, it is by no means certain that the nays would win it. The most they could expect would be the Scotch verdict, "not proven,"—and this not because much, if any, additional evidence of the actual wearing out of any variety has turned up since, but because a

\* From Silliman's 'American Journal,' February 1875.

presumption has been raised under which the evidence would take a bias the other way. There is now in the minds of scientific men some reason to expect that certain varieties would die out in the long run; and this might have an important influence upon the interpretation of the facts that would be brought forward. Curiously enough, however, the recent discussions to which our attention has been called seem, on both sides, to have overlooked this matter.

But, first of all, the question needs to be more specifically stated if any good is to come from a discussion of it. There are varieties and varieties. They may, some of them, disappear or deteriorate, but yet not wear out—not come to an end from any inherent cause. One might even say, the younger they are the less the chance of survival unless well-cared for. They may be smothered out by the adverse force of superior numbers; they are even more likely to be bred out of existence by unprevented cross-fertilization, or to disappear from mere change of fashion. The question, however, is not so much about reversion to an ancestral state, or the falling off of a high-bred stock into an inferior condition. Of such cases it is enough to say that, when a variety or strain, of animal or vegetable, is led up to unusual fecundity, or size or product of any organ, for our good, and not for the good of the plant or animal itself, it can be kept so only by high feeding and exceptional care—and that with high feeding and artificial appliances come vastly increased liability to disease, which may practically annihilate the race. But then the race, like the burst boiler, could not be said to wear out; while if left to ordinary conditions, and allowed to degenerate back into a more natural, if less useful state, its hold on life would evidently be increased rather than diminished.

As to natural varieties or races under normal conditions, sexually propagated, it could readily be shown that they are neither more nor less likely to disappear from any inherent cause than the species from which they originated. Whether species wear out, *i. e.* have their rise, culmination, and decline from any inherent cause, is wholly a geological and very speculative problem, upon which, indeed, only vague conjectures can be offered. The matter actually under discussion concerns cultivated domesticated varieties only, and, as to plants, is covered by two questions.

First, *will races propagated by seed*, being so fixed that they come true to seed, and purely bred (not crossed with any other sort), continue so indefinitely, or *will they run out in time*—not die out, perhaps, but lose their distinguishing characters? Upon this, all we are able to say is that we know no reason why they

should wear out or deteriorate from any inherent cause. The transient existence or the deterioration and disappearance of many such races is sufficiently accounted for otherwise—as, in the case of extraordinarily exuberant varieties, such as mammoth fruits or roots, by increased liability to disease, already adverted to, or by the failure of the high feeding they demand. A common cause, in ordinary cases, is cross-breeding, through the agency of wind or insects, which is difficult to guard against. Or they go out of fashion and are superseded by others thought to be better; and so the old ones disappear.

Or, finally, they may revert to an ancestral form. As offspring tend to resemble grandparents almost as much as parents, and as a line of close-bred ancestry is generally prepotent, so newly originated varieties have always a tendency to reversion. This is pretty sure to show itself in some of the progeny of the earlier generations; and the breeder has to guard against it by rigid selection. But the older the variety is (that is, the longer the series of generations in which it has come true from seed), the less the chance of reversion: for, now, to be like the immediate parents is also to be like a long line of ancestry; and so all the influences concerned (that is, both parental and ancestral heritability) act in one and the same direction. So, since the older a race is the more reason it has to continue true, the presumption of the unlimited permanence of old races is very strong.

Of course the race itself may give off new varieties; but that is no interference with the vitality of the original stock. If some of the new varieties supplant the old, that will not be because the unvaried stock is worn out or decrepit with age, but because in wild nature the newer forms are better adapted to the surroundings, or, under man's care, better adapted to his wants or fancies.

The second question, and one upon which the discussion about the wearing-out of varieties generally turns, is, *Will varieties propagated from buds (i. e. by division), grafts, bulbs, tubers, and the like necessarily deteriorate and die out?* First, Do they die out as a matter of fact? Upon this the testimony has all along been conflicting. Andrew Knight was sure that they do; and there could hardly be a more trustworthy witness.

“The fact,” he says, fifty years ago, “that certain varieties of some species of fruit which have been long cultivated cannot now be made to grow in the same soils, and under the same mode of management which was a century ago so perfectly successful, is placed beyond the reach of controversy. Every experiment which seemed to afford the slightest pros-

pect of success was tried by myself and others to propagate the old varieties of the apple and pear which formerly constituted the orchards of Herefordshire, without a single healthy or efficient tree having been obtained; and, I believe, all attempts to propagate these varieties have, during some years, wholly ceased to be made."

To this it was replied, in that the next generation, that cultivated vines have been transmitted by perpetual division from the time of the Romans, and that several of the sorts, still prized and prolific, are well identified, among them the ancient *Græcula* (considered to be the modern Corinth or currant grape), which has immemorially been seedless, that the old nonpareil apple was known in the time of Queen Elizabeth, that the white beurré pears of France have been propagated from the earliest times, and that golden pippins, St.-Michael pears, and others said to have run out were still to be had in good condition.

Coming down to the present year, a glance through the proceedings of pomological societies, and the debates of farmers' clubs, brings out the same difference of opinion. The testimony is nearly equally divided. Perhaps the larger number speak of the deterioration and failure of particular old sorts; but when the question turns on "wearing out," the positive evidence of vigorous trees and sound fruits is most telling. A little positive testimony outweighs a good deal of negative. This cannot readily be explained away, while the failures may be, by exhaustion of soil, incoming of disease, or alteration of climate or circumstances. On the other hand, it may be urged that, if a variety of this sort is fated to become decrepit and die out, it is not bound to die out all at once and everywhere at the same time. It would be expected first to give way wherever it is weakest, from whatever cause. This consideration has an important bearing upon the final question, Are old varieties of this kind on the way to die out on account of their age or any inherent limit of vitality?

Here, again, Mr. Knight took an extreme view. In his essay in the 'Philosophical Transactions,' published in the year 1810, he propounded the theory, not merely of a natural limit to varieties from grafts and cuttings, but even that they would not survive the natural term of the life of the seedling trees from which they were originally taken. Whatever may have been his view of the natural term of the life of a tree, and of a cutting being merely a part of the individual that produced it, there is no doubt that he laid himself open to the effective replies which were made from all sides at the time,

and have lost none of their force since. Weeping willows, bread-fruits, bananas, sugar-cane, tiger lilies, Jerusalem artichokes, and the like have been propagated for a long while in this way without evident decadence.

Moreover the analogy upon which his hypothesis is founded will not hold. Whether or not one adopts the present writer's conception, that individuality is not actually reached or maintained in the vegetable world, it is clear enough that a common plant or tree is not an individual in the sense that a horse or man, or any one of the higher animals, is—that it is an individual only in the sense that a branching zoophyte or mass of coral is. *Solvitur crescendo*: the tree and the branch equally demonstrate that they are not individuals, by being divided with impunity and advantage, with no loss of life, but much increase. It looks odd enough to see a writer like Mr. Sisley reproducing the old hypothesis in so bare a form as this—"I am prepared to maintain that varieties are individuals, and that as they are born they must die, like other individuals." "We know that oaks, sequoias, and other trees live several centuries; but how many, we do not exactly know. But that they must die, no one in his senses will dispute." Now what people in their senses do dispute is, not that the tree will die, but that other trees, established from cuttings of it, will die with it.

But does it follow from this that non-sexually propagated varieties are endowed with the same power of unlimited duration that are possessed by varieties and species propagated sexually (*i. e.* by seed)? Those who think so jump too soon at their conclusion. For, as to the facts, it is not enough to point out the diseases or the trouble in the soil or the atmosphere to which certain old fruits are succumbing, nor to prove that a parasitic fungus (*Peronospora infestans*) is what is the matter with potatoes. For how else would constitutional debility, if such there be, more naturally manifest itself than in such increased liability or diminished resistance to such attacks? And if you say that anyhow such varieties do not die of old age (meaning that each individual attacked does not die of old age, but of manifest disease), it may be asked in return, What individual man ever dies of old age in any other sense than of a similar inability to resist invasions which in earlier years would have produced no noticeable effect? Aged people die of a slight cold or a slight accident; but the inevitable weakness that attends old age is what makes these slight attacks fatal.

Finally, there is a philosophical argument which tells strongly for some limitations of the duration of non-sexually-

propagated forms, one that probably Knight never thought of, but which we should not have expected recent writers to overlook. When Mr. Darwin announced the principle that cross-fertilization between the individuals of a species is the plan of nature, and is practically so universal that it fairly sustains his inference that no hermaphrodite species continually self-fertilized would continue to exist, he made it clear to all who apprehend and receive the principle, that a series of plants propagated by buds only must have weaker hold of life than a series reproduced by seed. For the former is the closest possible kind of close breeding. Upon this ground such varieties may be expected ultimately to die out; but "the mills of the gods grind so exceedingly slow," that we cannot say that any particular grist has been actually ground out under human observation.

If it be asked how the asserted principle is proved or made probable, we can here merely say that the proof is wholly inferential. But the inference is drawn from such a vast array of facts that it is well nigh irresistible. It is the legitimate explanation of those arrangements in nature to secure cross-fertilization in the species, either constantly or occasionally, which are so general, so varied and diverse, and, we may add, so exquisite and wonderful, that, once propounded, we see that it must be true. What else, indeed, is the meaning and use of sexual reproduction? Not simply increase in numbers; for that is otherwise effectually provided for by budding propagation in plants and many of the lower animals. There are plants, indeed, of the lower sort, in which the whole multiplication takes place in this way, and with great rapidity. These also have sexual reproduction; but in it two old individuals are always destroyed to make a single new one! Here propagation diminishes the number of individuals 50 per cent. Who can suppose that such a costly process as this, and that all the exquisite arrangements for cross-fertilization in hermaphrodite plants, do not subserve some most important purpose? How and why the union of two organisms, or generally of two very minute portions of them, should reinforce vitality, we do not know and can hardly conjecture. But this must be the meaning of sexual reproduction.

The conclusion of the matter from the scientific point of view is, that sexually propagated varieties, or races, although liable to disappear through change, need not be expected to wear out, and there is no proof that they do—but that non-sexually propagated varieties, though not liable to change, may theoretically be expected to wear out, but to be a very long time about it.

XXVI.—*Oceanic Sediments, and their Relation to Geological Formations.* By Professor WILLIAM KING, Sc.D. &c.

THE valuable "preliminary reports" by Professor Wyville Thomson, M.D. &c., in parts 154 & 156 of the 'Proceedings' of the Royal Society, demand the special attention of geologists, as making known some important facts elucidating the sedimentary or depositional phenomena of the ocean in past periods of our globe.

When my Notices \* were published on the various objects obtained by the soundings of H.M.S. 'Porcupine,' during her Atlantic-Telegraph Survey Expedition off the west coast of Ireland, in 1862, the belief was gaining ground that the calcareous ooze occurring at great depths in the ocean is formed of the testaceous débris of Foraminifera that habitually live on its bottom. Ehrenberg, finding sarcode in the foraminifer-shells brought up from the bed of the subarctic Atlantic by Colonel Schaffner, appears to have been the first to give a decided expression to this view; though it had previously found favour with Professor Bailey, and was forcibly advocated afterwards by Wallich. The discoveries of Huxley, Berryman, and others strongly tended in the same direction. Influenced by these authorities, and taking various matters into consideration, I was induced to express the belief that the floor of the deep Atlantic is crowded with living *Globigerinæ* and *Orbulinæ*. Subsequently, in 1869, Doctors W. B. Carpenter and Wyville Thomson formed and expressed a very strong opinion on the same side. However, the researches lately made by the latter have led him to renounce this opinion, and to contend, like Major Owen and Dr. Gwyn Jeffreys, that the ooze-forming organisms inhabit the superficial stratum of the ocean, from the surface to about 100 fathoms in depth. I should have readily subscribed to the same view, but for certain facts which appear to oppose it. There are no unequivocal instances of living examples of the organisms referred to having been found in *mid-ocean* at the surface †. Major Owen's accounts (also apparently Lieut. Palmer's, which I have not been able to consult) have been accepted as proving that *Globigerina* and *Orbulina* are inhabitants of the superficial stratum, rising and

\* See 'Nautical Magazine,' December 1862; and 'Fraser's Magazine,' October 1863.

† The cases cited of Müller and Hæckel having taken live specimens of *Globigerina* and *Orbulina* in the tow-net must be eliminated, as they belong to shallow depths not far from land, where the creatures may not only live at the bottom, but may occasionally rise to the surface, or be brought up through adhering to pieces of seaweed that have got detached from the bottom.



sinking in it at will; but there is nothing recorded to support the idea that they are alive, except their occurring in the greatest numbers on the surface after sunset; from which it is inferred that they avoid the light. The presumed fact is certainly singular if the creatures are dead, though it may not be beyond a physical explanation. But if they are living, it is equally singular that no manifestations of vital functions have been observed, as far as I can ascertain, in any captured specimens, by those who have had the opportunity of examining them. Prof. Wyville Thomson and assistant Mr. Murray (who has been paying the closest attention to the floating Foraminifera) would scarcely be unmindful of this matter; yet it is noteworthy that they "never have been able to detect in any of the large number of *Globigerina* which have been examined" by them "the least trace of pseudopodia, or any extension in any form of the sarcode beyond the shell." Moreover the chambers are often almost empty, even in the freshest-looking specimens; or they contain sarcode apparently in no other than the unsatisfactory condition it presented to Bailey, Ehrenberg, Wallich, and others. So far, then, I see no reason to change the opinion which is expressed in my Notices of 1862.

In order to explain all the circumstances under which the ooze-forming foraminifers occur, I am induced to make the following suggestions in accordance with the assumption that they live at the bottom. As soon as a *Globigerine* or an *Orbuline* dies, the decomposition of the sarcode generates within the chambers sufficient carbonic-acid gas to cause it to rise to the surface. Here, the sarcode being still in process of decomposition, gas continues to be discharged from the chambers alternately with the intromission of water: these actions give rise to variations in the specific gravity and, as a consequence, to opposite vertical movements of the shell. It is conceivable, all other conditions being favourable, that occasionally, after the superficial stratum of the ocean has got warmed by the noon-day sun, the elevated temperature, and the consequent acceleration of the decomposition of the sarcode, would largely increase the generation of gas, thereby causing the shell to rise to or near the surface towards or after sunset: during the night, on the gas escaping and its replacement by water, the shell would descend again\*. Thus, as long as decomposition

\* It is stated by Lewy that the amount of oxygen in sea-water is somewhat greater during the day than it is at night, the reverse being the case as regards carbonic acid (Bischof, vol. i. p. 115). May not this difference have something to do with the rising of the shells during the night?

of the sarcode was carried on within its chambers, a foraminifer-shell would be limited to the superficial stratum, rising and sinking therein, as if it were animated and it preferred darkness to light. Eventually, gas ceasing to be generated, and the chambers becoming filled with water, the shell sinks to the bottom.

These suggestions, it appears to me, are fully capable of explaining not only the presence of foraminifer-shells in the greatest abundance in the superficial stratum after sunset (assuming that the observations made by Major Owen and others are conclusive on this point\*), but how it is that the specimens taken in the tow-net are often fresh, transparent, and occasionally furnished with spines in a wonderful state of preservation†; while those obtained from the bottom are usually in an opaque or chalky condition. On the view that these organisms habitually live at the bottom, it may be urged that some specimens in the living state ought to be brought up by the dredge or sounding-apparatus. Considerable doubt, however, may be entertained as to such possessing any vital power, considering the greatly altered conditions of temperature and pressure they would be subject to during the ascent; and it is highly improbable that many of them would retain their delicate spines. As the problem does not seem to be difficult of solution, let us hope that it will not remain long in its present unsettled state.

As regards the nature of the various substances forming the sea-bottoms, the general concurrence of the recorded observations goes far to prove that generally wherever the depth increases beyond 2600 fathoms the foraminifer-ooze gives place to argillaceous deposits, one kind marked "grey ooze" and the other "red clay" in the 'Challenger's' charts,—that, instead of a substance convertible into limestone or chalk, there occurs at depths approaching and exceeding 3000 fathoms a sediment essentially consisting of silica, red oxide of iron, and alumina. The two formations pass into each other by

\* The naturalists of the 'Challenger' are silent on this point: on the contrary, they mention that *Pulvinulina Menardi*, which largely contributes to the formation of the ooze, is very abundant at the surface, and still more so during the day at a depth of from 10 to 20 fathoms.

† Hückel has thrown out the suggestion that the spines with which *Orbulina* and *Globigerina* are crowded "probably contribute essentially to enable these little animals to float below the surface of the water by greatly increasing their surface, and consequently their friction against the water, and rendering it more difficult for them to sink." But the force of this suggestion is altogether weakened by the fact that *Pulvinulina*, equally considered to be surface-swimmers, do not possess any spines.

gradations apparently consequent on occupying intermediate depths, and often represented by the grey ooze. It would also appear that at the greatest ascertained depths conditions prevail unfavourable to the existence of organisms with calciferous tissues or calcareous skeletons. Life, however, still exists in the abyssal basins where the grey and red clays are formed. In several hauls, in one instance from 2975 fathoms, there were brought up:—holothurids of considerable size with rudimentary calcareous neck-rings; delicate branching, almost membranous Bryozoa; tube-building annelids, and tests of Foraminifera, the two latter being made up of particles of the red clay alone. And on one occasion, between Kerguelen Island and Melbourne, the "red clay," at the depth of 2600 fathoms, yielded Holothurians, starfishes, Actinias, Palliobranchs, *Euplectella*-sponges, &c.: those with calcareous parts were rather stunted.

Considering the existence in the ocean of vast numbers of diatoms, polycystines (these, there is no doubt, habitually live at or near the surface), sponges, and other organisms, whose skeletons consist of silica—also that rock-particles in the finest state of division, from their occurrence everywhere in the atmosphere, must be scattered over the sea-bottom by the distributive action of currents, it was to be expected that the foraminifer-ooze would not be purely calcareous. The analyses published by Messrs. David Forbes and John Hunter (late of the Queen's College, Belfast) show that such is actually the fact—the former having found, in a specimen from the depth of 2435 fathoms, 23·34 silica, 5·91 ferric oxide, 5·35 alumina\*; the latter, in a specimen taken in 1443 fathoms, 26·77 fine insoluble gritty sand (rock-débris), 1·33 alumina (soluble in acids), and 2·17 sesquioxide of iron (soluble in acids) †. Mr. Buchanan, of the 'Challenger,' has found 1 per cent. of a reddish mud, consisting of silica, alumina, and red oxide of iron, after washing and subjecting samples of the ooze to the action of weak acid. These results seem to have satisfied the scientific Director of the Survey that, allowing certain difficulties as mere matters of detail, the question as to the origin of the red clay is in the main solved. Grant sufficient free carbonic acid in the water of deep ocean-basins to dissolve all calcareous bodies, such as foraminifer-shells, that fall into them, the insoluble constituent alone will remain as a deposit. Professor W. C. Williamson proposed a similar hypothesis many years ago to account for the absence of calcareous shells in the siliceous (Diatomaceous) deposits of Bermuda and Vir-

\* Proc. Royal Soc. vol. xviii. p. 490.

† *Ib.* p. 428.

ginia, assuming that at one time they were like the Levant mud, in which there is generally an admixture of calcareous and siliceous organisms\*.

There are certain facts in geology which show analogous changes effected by the agency of carbonic acid: the most striking that occurs to me is the conversion, by means of this solvent, of beds of argillaceous limestone (Carboniferous) into highly aluminous rotten-stone, in Derbyshire and Glamorganshire. Nevertheless there are some grounds for refusing to look upon the "red-clay" basins as so many Upas valleys. If carbonic acid destroyed all the shell-structures carried into them, the water would necessarily become charged with bicarbonate of lime in solution; but from the various analyses hitherto made of sea-water, the quantity it contains of this salt appears to be very small compared with the amount of sulphate of lime. Carbonic acid may be the agent; but I am more in favour of sulphuric or rather sulphurous acid, considering that such is not unlikely to be produced by the oxidation of sulphuretted hydrogen, derived from the decomposition of organic matter—also the presence of its decomposing agent (oxygen), as determined by Messrs. Lant Carpenter and Buchanan, in the depths of the ocean †.

Subjected to the action of sulphurous acid, the substance of all calcareous shells in a *dead* condition would be ultimately converted into soluble sulphate of lime, with liberation of carbonic acid ‡; and thus the ocean would be perpetually supplied

\* Transactions of the Manchester Literary and Philosophical Society, 1847. It must not be overlooked that the siliceous organisms which occur in the foraminifer-ooze in appreciable proportion have likewise for the most part disappeared in the red clay, through the action of some dissolving agent. Crystals of quartz, from Zinnwald, are not uncommon with their planes corroded and deeply excavated in places originally occupied by oligist—showing that the silica has been in some way removed by the action of a ferric oxide; the fact is of some significance in connexion with the disappearance of the siliceous organisms from the red clay. I may add that Mr. H. J. Carter has called attention to the rapid wasting or decay which siliceous (also calcareous) spicules of sponges undergo in his cabinet, whether mounted or unmounted, also in living specimens (see *Ann. & Mag. Nat. Hist.* 1873, vol. xii. pp. 456, 457). This destruction appears to be due to solvent action of another kind.

† I have had some experience of the presence of sulphuretted hydrogen in the ocean during a strong gale of three days' duration on the west side of the Doggerbank, while on one of my dredging-expeditions, some thirty years ago. The agitation of the sediment at the depth of about forty fathoms by the heavy seas caused so much of this gas to rise to the surface that my watch, a silver one, became quite blackened by its action.

‡ When Bischof wrote his 'Chemical and Physical Geology' very little was known respecting the abundance of calcareous organisms at the bottom of deep oceans. Fixing his attention on the vast amount of

with its most abundant calcic constituent. The same process, it may be urged, would take place over the shallower areas covered with foraminifer-ooze. Admitted, but with this difference: in the "red-clay" basins foraminifer life evidently approaches zero, whereas in shallower areas it is unquestionably in the ascendant; therefore any loss of lime the latter areas may sustain through the action of sulphurous acid, would be made up by *living* Foraminifera converting the sulphate of lime in the surrounding water into the carbonate composing their shells.

Doubtless, whatever the agent may be that produces the "red-clay" deposit, it has contributed more or less to the production of similar or related formations belonging to different geological periods—though they may be of any colour, depending on the relative amount of their constituents and the nature of their combination. Certain supersilicated rocks (as novaculite, fuller's earth, chamoisite, &c.) suggest themselves in connexion with this idea; and it is highly probable that many of the glauconites were originally red clays (the residue of foraminifer-ooze), part of the peroxide of iron of the latter having been reduced to a protoxide by organic matter. I cannot, however, think it is correct to associate the Oldhamian schists (Cambrian) with this idea—that is, "to suspect that they may be organic formations like the modern red clay of the Atlantic and Southern sea, accumulations of the insoluble ashes of shelled creatures." The thousands of feet of Cambrian schists would require the existence somewhere of vastly more thousands of feet of synchronous limestones. But where are they? In the recently published paper by Mr. T. Davidson and myself on the *Trimerellidae* this question was briefly discussed\*. Failing to ascertain the existence of any limestones of the kind, we made the suggestion that the Cambrian seas were not inhabited by organisms furnished with calcareous skeletons, or they did not contain the ordinary amount of calcic constituents. I do not dispute that

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bicarbonate of lime carried into the sea by rivers, he naturally concluded that this salt was appropriated by shell-fish. Nevertheless I must still adhere to the opinion I expressed in 1862, that pelagic animals obtain calcic matter from the sulphate of lime contained in the surrounding water. I find that Forchhammer is of opinion "that Testacea decompose the latter substance by means of carbonate of ammonia formed by their agency." Bischof thinks that "it might likewise be decomposed by the organic matter of marine animals into sulphide of calcium, which would be decomposed by the carbonic acid produced by them" (see 'Chemical Geology,' vol. i. p. 180, footnote).

\* Quarterly Journal of the Geological Society, May 1874.

calcareous rocks belonging to the Cambrian system may yet be found; but considerable doubts may be entertained of their occurring in it to any extent except as methylosed members.

The facts brought to light by the various submarine surveys that have been made show how simple, yet grand, are the depositional phenomena of the ocean; but they place before the geologist nothing more than the materials that enter into the composition of ordinary sedimentary rocks in their *normal* condition. During the Wernerian stage in the progress of geology the doctrine was taught that crystalline rocks were the products of oceanic precipitations. Other doctrines took its place. Of late years, however, it has been revived, with novel accessories. Judging from the results of the surveys referred to, the chances seem to be extremely remote that any sea-bottoms will ever yield to the dredge samples of *direct crystalline precipitates* having the least relation to the Laurentian diorites, ophites, syenites and the like, as products of our present oceans.

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XXVII.—*Remarks on Professor Owen's Arrangement of the Fossil Kangaroos*\*. By GERARD KREFFT†.

THE first part of Professor Owen's work describing the fossil kangaroos has just been received; and as some new genera have been added, it will no doubt interest readers of the 'Sydney Mail' to hear how these divisions have been defined. The learned Professor pays a just tribute to John Gould, F.R.S., "through whose adventurous journeys, and by the noble works in which he has given the result of his observations in Australia and Tasmania, we mainly know the extent and kinds of variations under which the kangaroo there exists." There is more in this sentence than many people imagine, because Professor Owen no longer hesitates to speak "evolutionally" † about the subject. It has been pointed out by me on several occasions, and chiefly in papers read before the Royal Society of New South Wales, that the whole of our extinct and living marsupials were offshoots or branches of a kind of animal which combined the dental structure of both the carnivores and herbivores of the marsupial section. The

\* "On the Fossil Mammals of Australia.—Part VIII. Family Macropodidæ: Genera *Macropus*, *Phascolagus*, *Sthenurus*, and *Protomnodon* (Phil. Trans. 1874, pt. i. pp. 245-287, pls. xx.-xxvii.), by Professor Owen, F.R.S.

† From the 'Sydney Mail,' Dec. 26, 1874. Communicated by the author.

‡ Royal Society's 'Philosophical Transactions' for 1874, p. 255.

*Thylacoleo* was the last representative of this early progenitor of our marsupials; and in this form only occur carnivorous grinders with an otherwise herbivorous dentition. There must have been numerous intermediate forms totally lost, or not yet discovered, which would clear up our doubts upon the subject; so much is certain, however, that with the *Thylacoleo* disappeared the nearest relation of the most ancient form of marsupial life in this country.

Supposing, then, this hypothesis to be correct, we can well account for the development of the rest of the pouched tribe, and simply divide them into two groups,—No. 1 embracing all the members with a pair of small conjoined inner toes—that is, kangaroos, rat-kangaroos, wombats, phalangers (opossums, flying squirrels, native bears, &c.), and bandicoots; whilst No. 2, on the other hand, comprises the true flesh-eaters, without the conjoined inner pair of toes, such as the Tasmanian tiger and devil, the dasyures or native cats, and the small fry of pouched mice.

All our marsupials can be received into one or the other of these groups; so that, after all, the classification of them is easy enough. It may be argued that the dentition varies much; but when we study embryonic life and the development of the teeth, we soon find the missing links; and if a person will only take the trouble to look for himself before implicitly believing what is published, he will soon change his opinion. Let us take a wombat, an opossum, and a bandicoot for a comparison: and certainly there are not three animals in the group more different from each other than these; but all three possess the conjoined toes to the hind feet. When the teeth of a very young wombat are examined, it becomes also clear that they are furnished with crowns or working-surfaces which very much resemble those of our common phalanger or opossum; and when we take the trouble to disengage the grinders of certain bandicoots, such as the *Peragalea* or rabbit-rat, we behold a “small edition” of a true wombat’s grinders. Of course it is necessary to find out such things by actual examination; and it must be admitted that few persons have the opportunity, or, if so, make use of it.

The native bear is the diminutive representative of the gigantic extinct Phalangers, the Diprotodons, and Nototheres; and he is also the most ancient living form of marsupial life, probably connected by innumerable unknown species with the lower section to which the platypus belongs. At any rate, there is no other animal known to me which, at an early period of its existence, has grinders resembling the horny “apologies for teeth” wherewith our “duckbill” is supplied

when adult. Of course the resemblance is remote, very much so; but there is a resemblance nevertheless. Again, we have rat-kangaroos, which (when despatched in skins without skulls) have been taken more than once for bandicoots by the best European authorities; and there were kangaroos once upon a time which had firmly joined lower jaws, and others with compressed grinders, not unlike the carnivorous marsupials. These two latter groups are not referred to by Professor Owen in part viii., and they will probably be discussed at some future time.

The Professor's treatise is illustrated by eight splendidly executed plates of the newly created genera, some of which represent unique specimens from the Australian-Museum collection; and so faithfully executed are they, that I recognized the figures at a glance, though I have not had an opportunity to look at the originals for six months and more. Professor Owen has found it necessary to alter the existing arrangement of the kangaroo tribe, retaining the term *Macropus* for all the kangaroos proper, for the wallaroos (*Osphranter*), and for the wallabies (*Halmaturus*) and rock-wallabies (*Petrogale*). It appears, however, that, if we must subdivide the fossil species into several genera, we cannot well discard the arrangement formerly proposed and generally adopted\*, which is simple, comprehensive, and meets all our wants.

This arrangement is as follows:—

#### Genus MACROPUS.

Large kangaroos with small premolar teeth, which are soon lost.

#### Genus HALMATURUS.

Kangaroos of smaller size, with permanent premolar teeth. This second group is capable of subdivision into four genera or subgenera, and the last, the rat-kangaroos, into two more.

Of course it rests with naturalists which system to adopt; but as few museums have so extensive a series of kangaroo skulls and skeletons as our own, we must have some voice in the matter, and cannot be expected to change our arrangement except upon more solid grounds than those given in Professor Owen's comprehensive paper.

Looking at the splendid drawings, we miss one of the chief characteristics of a kangaroo's skull; and that is the upper incisive dentitions of the fossil species †. Without this, a proper

\* 'Australian Vertebrata, Fossil and Recent,' by Gerard Krefft, p. 10.

† I have seen some proof-plates of skulls of Prof. Owen's second part of the Macropodidæ without the important *incisive dentition*; but I do not think that the shape of the teeth, as indicated by faint lines, is correct.—G. K.



classification cannot be attempted; and it is much to be regretted that the author had so little material at his command at the time. Since the work was published, Professor Owen has received numerous additional proofs, through his chief contributor and friend, Dr. George Bennett, and amongst these at least a dozen fragments of skulls, with the incisors perfect or nearly so. The grinding-series differs much in some groups; and seldom can a pair of skulls be found which have the teeth alike. The grinders are always subject to more than the usual variation; and for this purpose large quantities of skulls were brought together and examined here before classification was attempted. The result led to the conclusion that by the upper front teeth only (of half-grown or almost adult individuals) can skulls be named with certainty. There are two kinds of third upper incisors which occur with premolars of a certain form; and this sanctions the division into two large groups as above, with the following additional characteristics.

### 1. MACROPUS.

With a broad third upper cutting-tooth (without a fold or groove when adult), with deciduous premolars, and subject to shedding the grinders up to a single pair in each ramus in old age.

### 2. HALMATURUS.

With rather narrow and grooved third upper incisors and a more permanent dentition, the grinders being worn down but seldom shed. Besides this distinguishing point, the distance between the lower incisor and the premolar must be considered; and the wider this space, the sooner the teeth are reduced in number; the shorter, the longer are the grinders retained.

Compare this space in a wallaby's jaw with that of a kangaroo, and the difference will be understood at once. A long-headed kangaroo sheds the grinders, whilst a short-headed wallaby wears them out.

To illustrate this it is necessary to refer to the author's splendid illustrations. On plate xx. we have a long-headed kangaroo (under fig. 1), certainly with a short upper third incisor, but with every indication that the grinders will be shed with age and not worn down. Figures 13 and 15 represent similar animals, who shed their teeth; but No. 11 (a rock-wallaby's lower jaw) belongs to the "grinding-down" section, and in this the space between incisors and molars is very short.

On plate xxiv. (figures 10, 11, and 12) the lower dentition of our black wallaby is given. The wear of the incisor below, and the corresponding teeth above, shows that the animal was fully adult, but had not shed the premolar, as true

kangaroos invariably do about that period. Figure 1, representing the skull with a front tooth lost, proves, first, that the author had not the material required; otherwise a more perfect figure would have been given; it also shows that the value of the upper incisors as a means of classification is reduced with age, because the incisors, being much worn, lose their original shape completely.

On plate xxv. fine illustrations are given of *Protemnodon Anak*—that is, of a gigantic wallaby who kept his teeth and ground them down, but did not shed them as kangaroos do; this is, of course, a member of the genus *Halmaturus*, as we have hitherto classed the tribe. Suppose we designate this creature as *Halmaturus (Protemnodon) Anak*. It appears, from remarks on page 261, that the author desires to retain the genus *Osphranter*; but a definition of the characteristics of the genus are not given. Mr. Gould founded it on external characters only; and not having a skull at my command, particulars cannot be furnished. There is no doubt that wallaroos identical with the present wallaroo which inhabits the Clarence district, once existed and left their remains in the Wellington caves; Professor Owen mentions their presence on the Darling Downs also.

The genus *Phascolagus* is mentioned as being found in a fossil state by Dr. Bennett in Queensland. This form occurs living far north, where Mr. George F. Waterhouse, of the Adelaide Museum, obtained the typical specimen. It appears to be a link between the wallabies and kangaroos proper, the head being long; but the third upper incisor is a narrow tooth, and therefore the animal does not correspond with the kangaroos proper, which have broad third upper incisors. The genus *Boriogale* is referred to in several places on pages 263 and 264, founded on anatomical points of the skull, which cannot be distinguished without specimens. As far as I can remember, the teeth resemble those of the wallaroo. The large fossil wallaby, hitherto known to us as *Macropus* (or *Halmaturus*) *Atlas*, is now classed under the designation of *Sthenurus Atlas*. This is also a true wallaby, the form of whose lower premolar teeth approaches those of certain extinct phalangers of the genus *Nototherium*. Several new species of each genus are described in the treatise, which can be referred to at the Public Library.

The next part of the learned author's work will probably bring the kangaroo tribe to a close; and we may confidently expect to see figured therein some of the well-preserved specimens forwarded by Dr. Bennett during the last six months. Surveying the part as a whole, it must be considered a

splendid addition to the elucidation of Australian natural history; and it is to be hoped that another grant will be made by our liberal Legislature to enable the author to finish his great undertaking.

XXVIII.—*Zoologico-Embryological Investigations*.

By M. Ussow.

[Continued from p. 113.]

IV. *Appearance of the Organs*.

We may now pass to the second period \*, that of the production of the organs. On the first day of this period (in *Sepiola* and *Loligo* the ninth day from the beginning of the process of segmentation) the rhomboidal groove already described gradually becomes deeper, and covered over by the elongate-ovate constantly growing fold, which is separating by constriction at the ventral side and assuming the form of a shield. Towards the end of this period the margins of the fold begin to grow together, and the rhomboidal groove becomes converted into a flat tube, somewhat broader in the middle (especially in *Sepia*).

The scutiform hill-like elevation (originating from the coalesced fold) which lies over the tube chiefly on the dorsal surface, and which is gradually constricted, is the rudiment of the *mantle*; whilst the *os Sepie* will subsequently be formed in the above-mentioned tube closed at both ends and widest in the middle (*Sepia*, *Loligo*, *Sepiola*, *Ommastrephes*, *Rossia*). The elevation, separating by constriction at the ventral side, grows both upwards and downwards, and acquires first the form of a cup and then that of a cylinder.

The walls of the so-called primitive groove †, which is con-

\* In *Loligo*, *Sepiola*, and *Argonauta* the second period of development lasts five days. In this paper I follow Metschnikoff's division of the development of the Cephalopoda into three consecutive periods:—first, the formation of the germ-lamellæ; second, the appearance of the organs; third, the gradual further development of the organs.

† The position of this rhomboidal depression upon the dorsal surface, its early appearance (before all the organs), its further mode of development, are all facts which remind us of the primitive groove of the Vertebrata: and taking them into consideration, it may likewise be called the primitive groove, although as a matter of course there can be no question of comparing it more closely with the primitive groove of the Vertebrata, as the two rudiments represent fundamentally different organs. Although a groove is also at first formed in the Octopoda (*Argonauta*), this does not become closed (except in the genus *Cirrhoteuthis* ?), but becomes gradually effaced and finally disappears entirely. With regard to *Argonauta*, I must remark that Kölliker has described and figured the groove (*l. c.* p. 163, Taf. vi. figs. 71-73) as "a rather deep, funnel-shaped pit."

verted into a tube in the manner above mentioned, consist of a single layer of cells \* of the upper germ-lamella; whilst in the oval fold (rudiment of the mantle), besides the elongated cylindrical cells situated at its surface, there are also two layers of cells of the middle germ-lamella. The first of these layers (dermo-muscular layer), constantly increasing with the development of the fold, becomes more than one-layered under its margins †, and therefore also thicker; and this thickening is the immediate cause of the eversion of the fold over the blastoderm and its constriction on the ventral side.

Besides the above-mentioned organs, the rudiments of *eye-ovals* and of the *buccal orifice* make their appearance at this time. The buccal orifice, which can only be recognized with some trouble from without, appears in longitudinal sections of this stage as a very shallow depression of the upper germ-lamella. The rudiments of the eyes, which lie symmetrically on the sides of the dorsal surface, are developed chiefly from the elongated cells of the upper germ-lamella, the single series of which forms a longish oval convexity ‡ above the blastoderm.

The Cephalopod embryo, freed from the nutritive vitellus in the manner already described (see p. 100, note †), in this first stage of the production of the organs has the form of a convex disk, or rather of a hollow hemisphere, composed of more than one layer and more or less thickened in many places. The earliest and most considerable thickening corresponds to the scutiform mantle-rudiment, pointed on the dorsal surface, and curvilinearly bounded on the ventral side by the above-described rhomboidal groove, which in transverse

\* The cylindrical cells lining the bottom of the groove are rather tall, whilst the layer which covers the groove and subsequently grows together consists of small flat cells. Some agreement in the production of this groove and that of the intestino-glandular [epithelial] layer of certain animals (*e. g.* the Arthropoda), and the great resemblance of its cells underlying the upper germ-lamella to those of that layer, at first led me astray, and made me think that perhaps in the Cephalopoda also a portion of the intestinal tract is formed as in the Crustacea (see the remarkable Russian memoir of Bobrezky, "On the development of *Astacus* and *Palæmon*"). It was only a long series of repeated observations that convinced me of my original error.

† The part of the dermo-muscular layer which is situated between the groove and the surface of the mantle becomes converted (in the third period) into the *cutis* with its muscular and fibrous layer.

‡ This mode of development of the primitive eye-ovals, which are soon covered by a second fold of the upper lamella and then gradually begin to sink, has been quite correctly observed by Metschnikoff in *Sepiola* (*l. c.* pp. 43-49). As regards the other Cephalopoda, it is confirmed by my investigations; and consequently Kölliker's (*l. c.* p. 99) and Hensen's (*Zeitschr. für wiss. Zool.* Bd. xv. p. 183) statements prove to be erroneous.

sections appears as a shallow but wide depression of the upper germ-lamella. At the time of its appearance the rudiment of the mantle is situated in the middle of the original germinal disk (*centrum*), with by far the greater part of it on the dorsal surface, whilst the somewhat elevated (constricting) part which subsequently grows round the ventral surface occupies only a very inconsiderable space upon the latter.

Above the mantle there are symmetrically on the two sides of the dorsal surface the two eye-ovals, and between them, at the boundary of the region of the arms, the above-mentioned rudiment of the buccal orifice. The lateral surfaces of the embryo represent the future *cephalic lobes*.

On the following day, in all the Cephalopoda investigated by me, the *branchiæ*, the *funnel*, the *arms*, and the *anal tubercle* made their appearance. At the time when the rudiment of the mantle has become rather more constricted off from the blastoderm on the ventral surface, the cell-layer of the upper germ-lamella becomes somewhat thicker at the sides of the embryo (at first by longitudinal division, by which the cells are rendered higher, and then also by transverse division), and forms two inconsiderable prominences, which gradually grow and are the rudiments of the two so-called *cephalic lobes*.

As regards the rudiments of the *branchiæ*, which are at first situated on the ventral side of the embryo not far from the margin of the mantle, these are developed from the more than one-layered thickening \* of the dermo-muscular layer of the middle germ-lamella, which is covered by the cells of the upper lamella.

On the boundary between the anterior cephalic lobe and the rudiment of the mantle a semilunar fold makes its appearance on each side of the embryo, produced by a thickening of the dermo-muscular layer, and covered, like all the organs mentioned, by cells of the upper lamella. This is the rudiment of the *funnel*, which consists of two halves, the margins of which coalesce very late, indeed only at the commencement of the third period †.

Almost simultaneously with the appearance of the *branchiæ* there is formed between their pyriform rudiments, in the

\* At the end of the second and during the third period the cells in the middle of the solid branchial rudiments gradually become loosened, and tortuous reticulated ducts are produced in which the branchial arteries and veins with their numerous ramifications are formed (see Van Beneden, *l. c.* p. 9; Kölliker, *l. c.* p. 89; Metschnikoff, *l. c.* p. 61).

† On the dorsal surface the two halves of the funnel approach each other as early as the fourth day of the second period.

median line\* of the embryo, a rather inconsiderable prominence, which, like most of the outgrowths, proceeds from the second germ-lamella (in this case chiefly from the intestino-fibrous layer), and is also covered by the upper lamella. This prominence forms the first commencement of the *anus*. About the same time, in all the Cephalopoda investigated by me, the four (*Argonauta*) or five pairs of rudimentary arms make their appearance very rapidly after one another (at the utmost in two days; in some the first three pairs simultaneously †). This seems to confirm Van Beneden's ‡ observation, which was rejected by Kölliker § and afterwards by Metschnikoff ||. The rudiments of the arms are developed as hemispherical outgrowths, composed chiefly of the dermo-muscular layer and covered by cells of the blastoderm. They all make their appearance on the annular part of the germinal disk situated on the equator, which is formed by several (three or four) concentric series of large but flat cells, constricted off from the segments after the meridional segmentation, and at first lying scattered in isolated groups ¶.

On the third day of the second period the rudiments of the *auditory organs*, the *pharynx*, the *salivary glands*, the *anal orifice*, and the *external fold of the eye-ovals* are added to the organs already enumerated and now undergoing further development.

Between the outer margin of the rudiment of the funnel (at the part where its cartilages, although indistinctly, are beginning to be formed) and the commencement of the anterior cephalic lobe the upper lamella becomes a little depressed on both sides of the ventral surface of the embryo, and forms two (at first very small) pits, which are sharply marked in both longitudinal and transverse sections, and represent the rudiments of the auditory organs, only approaching each other at the close of the third period. Their trumpet-like peduncles, which at the end of the second period are entirely constricted off from the upper lamella, become converted into canals, which finally lie upon the auditory vesicle, which is completely separated from the outer surface. The walls of the latter soon become thicker in many parts \*\*.

\* In the longitudinal line which passes through the buccal aperture and the middle of the mantle, and divides the embryo into two symmetrical halves.

† In *Loligo*, *Sepiola*, and *Argonauta*.

‡ *Loc. cit.* p. 7, fig. 9.

§ *Loc. cit.* p. 60.

|| *Loc. cit.* p. 35.

¶ See description of the process of segmentation.

\*\* At the beginning of the third period, in all the Cephalopoda investigated by me, there are formed in the cavity of each auditory vesicle (0.32 millim. in diameter in *Loligo*), on its upper wall, shining granules

The pit-like depression of the upper lamella, which forms the buccal orifice, gradually penetrates deeper (between the two layers of fusiform cells of the intestino-fibrous layer, which lies between the nutritive vitellus and the dermo-muscular layer, which bound it); and at the bottom of this shallow pouch-like pit there is formed a small prominence composed of cells of the middle lamella (dermo-muscular layer). This prominence, which lies to one side at the hinder wall of the pit, and, like this, is covered by cells of the upper lamella, represents the hinder part of the pharynx, and becomes subsequently (in the third period) converted into the so-called organ of taste, with its muscular tissue and unciniate radula. Between the hinder wall of the original buccal cavity and the above-mentioned prominence the upper cell-layer of the latter closes into a thin and short cæcal tube. This tube lengthens pretty rapidly and then becomes forked, and thus forms the rudiment of the *efferent duct of the salivary glands*, which are developed (in the third period) at the ends of the two branches of the above-mentioned tube. The original funnel-shaped tube (wider above), however, represents in its upper part the rudiment of the *buccal cavity*, and in its lower part that of the *œsophagus* or *anterior intestine*. The other parts of the pharynx, the *lower* and *upper jaws*, and the thick muscle of the latter are developed in the third period—the jaws as a chitinous secretion of the epithelial envelope of the buccal cavity, and the muscle as a thickening of the dermo-muscular layer which is applied to the anterior wall of the original buccal pit.

The change which takes place on this (third) day in the anal prominence consists in the cells of the upper lamella forming in its centre an increasing depression, which is the rudiment of the anal aperture.

Over each of the thickened eye-ovals forming the primitive retina appears a fold, consisting of cells of the upper lamella, which grows rapidly, and covers the whole of the oval at the end of this second period, although a small aperture remains in the centre of the fold. At the same time small yellow

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(0.04 millim. in diameter), which soon unite together, consisting of a calcareous secretion from the cylindrical epithelial cells; and from these the two otoliths (0.048 millim. in diameter) originate. The canals which lie upon the auditory vesicles become bent (in the third period), and their internal epithelial walls covered with cilia. In general my observations on the development of the auditory organs agree with the results obtained by Metschnikoff in *Sepiolo* (*l. c.* pp. 49-53), but differ materially from those of Kölliker (*l. c.* p. 168).

pigment-granules are produced upon the surface of the retina\*.

The two cephalic lobes, which have now become considerably thicker, rise more and more above the nutritive vitellus; whilst the region of the arms, situated upon the equator, becomes constricted, and thus forms a narrower boundary between the embryo and the spherical yelk-sac. The embryo, when examined from either the ventral or dorsal side, has a lyriiform shape; its lower part (mantle) is considerably separated by constriction from the ventral surface, the middle part† tolerably broad; and the region of the arms forms a very noticeable notch between the yelk-sac and the true embryo. The nutritive vitellus enclosed within the embryo has the form of a hemisphere with a tuberculiform process which penetrates into the mantle on the dorsal surface.

The fourth day of the second period of development is characterized by the appearance of two spherical masses of cells of the intestino-fibrous layer of the middle lamella, which are situated on the ventral side of the embryo, near the sides of the branchiæ, at the apices of which two prominences are produced at this time. These solid aggregations of cells form the rudiment of the *auricles of the heart*, which are afterwards surrounded by a *pericardium*. The pericardium consists of a cell-layer of the upper lamella, which penetrates between the mantle and the funnel, and completely clothes the aggregations‡. The rudiment of the *ventricle of the heart* lies between the rudiments of the auricles, can only be detected with difficulty§, and consists of a solid aggregation of cells belonging to the intestino-fibrous layer, which is at first spherical but afterwards cylindrical. By degrees the cells separate from

\* With respect to the development of the organs of vision, I must add that the lens is formed at the beginning of the third period as a fluid, gradually hardening secretion of the *corpus ciliare* produced from the above-mentioned fold. Its form changes pretty rapidly from cylindrical to oval, and finally becomes spherical. In longitudinal and transverse sections of the embryos of *Argonauta*, *Loligo*, &c. the lens consists of concentric layers of a structureless transparent substance. In the third period the retina, consisting of two layers of cylindrical cells, which was at first convex, sinks and becomes semilunarily concave; the dark brown pigment, singularly enough, persists upon the surface of the retina until the close of embryonal life.

† From this part are gradually formed the head, all the organs enclosed within it, and some organs of the trunk.

‡ The very large pericardial cavity is very distinctly perceptible in the first half of the third period.

§ It is particularly distinct in sections of the first half of the third period, in the form of an oval aggregation of cells. The cavity, embraced by thin walls, is very slowly formed; so that the development of the auricles considerably precedes that of the ventricle.



each other in the centre of each aggregation, so that a gradually enlarging cavity is then produced, whilst the cells become elongated into a spindle-shape, and form rather thick muscular walls surrounding the cavity.

It is only in the third period, for example in embryos of *Sepia* which are only one third or one fourth of the size of their yolk-sac, that there are, besides the above-mentioned considerably developed and already pulsating central organs of circulation, two so-called *branchial hearts*, situated at the broad base of the two multitubercular branchiæ. The walls of the *aorta* and of all the other subsequently appearing great *arteries* (e. g. of the *optic ganglia*), *veins*, and their diverticula (so-called *kidneys*) are developed from the cells of the middle lamella, which become elongated and arrange themselves in rows. On the same day, behind each eye-oval, a spherical aggregation of cells of the middle germ-lamella separates; and these aggregations represent the rudiments of the *optic ganglia*. I shall go into more detail with regard to these in describing the formation of the nervous system.

At the end of the fourth day the cephalic lobes approach each other considerably, and the embryo rises above the nutritive vitellus, the walls of which, consisting only of a layer of cylindrical cells of the upper lamella and a layer of the middle lamella united to the former by means of thin, contractile protoplasmic processes, begin to contract rhythmically, by which the absorption of the nutritive vitellus is hastened.

At the same time, the cells of the middle lamella (the dermo-muscular layer) surrounding the auditory vesicles, which are connected with the outer world by means of their peduncles, become converted into the envelopes of the latter.

On the fifth and last day of the second period the thin œsophagus becomes deeper and extends nearly to the mantle, which at this time also rises somewhat on the back. In the anal pit, which has become somewhat deeper and acquired the appearance of a cæcal tube, a change takes place which is important, inasmuch as it divides near the entrance into two tubes\* :—an upper one, the rudiment of the *ink-sac*, which has at first the form of a thin short tube enlarged at its cæcal ex-

\* This division is effected as follows :—Under the bottom of the anal pit, which is covered by two or three layers of the intestino-fibrous layer, a small excrescence is formed, which gradually raises the bottom of the pit nearly up to the entrance, and in this way, as by a septum, divides the pit into two tubes branching off at an acute angle. The bottom of the upper tube soon becomes wider; and at the same time the cells of its walls become considerably longer and thicker. In this way is produced a sac furnished with a short efferent duct. The walls of the pit become higher and form the so-called anal lobes (*Sepia*, *Sepiola*). The

tremity; and a lower one, the perfectly straight rudiment, closed at the extremity, of the true *rectum*. The walls of these two tubes, as also the œsophagus, consist of a layer of cylindrical cells of the introverted upper lamella, surrounded by one or two layers of fusiform cells of the intestino-fibrous layer of the middle lamella.

The further development of the intestinal canal which takes place in the third period, consists in the continued growth and increase in depth of its parts above mentioned. The *stomach* is formed at first as a dilatation of the hinder part of the œsophagus, which, after it has lengthened parallel to the dorsal part of the mantle as far as one half the length of the latter, bends towards the ventral surface almost at a right angle, and unites\* with the lengthened primitive rectum, which is turned up towards the back.

At the point where the prolongation of the stomach meets the rectum a small dilatation is produced; and from this the *cæcum* is afterwards formed. At the close of the first half of the third period, in transverse and longitudinal sections of the Cephalopoda investigated by me, there are behind the ink-sac (which is already considerably developed), and at first nearer the ventral surface of the embryo, two blind, clavate, thick-walled tubules, which have been developed from a dilatation of the posterior part of the intestinal canal, and represent the rudiment of the *liver*. It is only in the postembryonic period, after the nutritive vitellus is entirely absorbed, that the two halves of the liver enlarge very rapidly, approach each other, and take up their ordinary place in the dorsal part.

The *proventriculus*, or so-called *crop*, is also developed in the embryo of *Argonauta* in the first half of the third period, as a dilatation of the œsophagus situated beneath the cerebral ganglion. The walls of all the dilatations above mentioned, which originate at different times, are formed from the various main and subordinate parts of the intestinal tract, and consist of one or two rows of fusiform cells of the intestino-fibrous

connexion between the ink-sac and the liver, formerly described by Van Beneden (*loc. cit.* p. 10), has no existence.

\* I have not succeeded in observing the moment of direct union; but from the evidence of longitudinal sections of certain stages, and, in fact, of embryos in which the long anterior intestine, enlarged at the extremity, extends to two thirds the height of the mantle (first half of the third period), and the rectum curves up towards the dorsal surface, and then of certain sections (from the second half of the third period) in which the slightly tortuous *tractus intestinalis* is visible in its whole length, I firmly believe that I may assert that this union in reality takes place.

layer, and of the cylindrical cells of the inward-bent upper germ-lamella, which therefore seems to play the part of the intestino-glandular layer of the embryos of other animals, representing, I believe, the introverted part of the upper lamella from which the intestinal cavity is formed in *Amphioxus*\*, the simple *Ascidia*†, and some Cœlenterata‡, Brachiopoda§, Vermes||, &c.

At no single stage of development of the Cephalopod embryo is the nutritive vitellus in any way directly connected with the cavity of the intestinal tract, which is completely separated from it, as, indeed, has already been remarked by Kölliker¶ and Metschnikoff\*\* in opposition to the erroneous statements of older investigators††. At the close of the second period the inner nutritive vitellus has the form of a cylinder, from which issue three processes. The inferior, sharp process is, as previously, imbedded in the mantle; whilst the two sickle-shaped lateral processes penetrate into the cephalic lobes behind the eyes, beneath the optic ganglia. The nutritive vitellus passes out of the yolk-sac into the embryo through a cylindrical, gradually narrowing canal formed by the coalescence of the cephalic lobes; it is situated between the œsophagus, the *ganglion pedale*, and the *ganglion viscerale*. During the whole period of development, the whole mass, both of the inner nutritive vitellus and of the outer nutritive vitellus (which is continually passing into the embryo), is gradually absorbed by the cells of different organs and tissues in contact with it.

This short exposition of the results of my tedious investigations (upon living embryos and sections of them of different kinds) of the development of the alimentary apparatus of the Cephalopoda contradicts in all points the erroneous opinion of Kölliker ††, that the intestinal tract originates as a solid cord, in which cavities are only produced subsequently, and confirms the accurate statements of Metschnikoff §§ as to the pro-

\* Mém. de l'Acad. de St. Pétersb. tome xi. pl. i. fig. 6, and pl. ii. fig. 20.

† *Ibid.* tome x. pl. i. figs. 10, 16.

‡ Götting. Nachr. 1868, p. 154 *et seqq.* Observations on the Development of the Cœlenterata (in Russian), 1873, pls. ii., iii., iv., vi.

§ Observations on the Development of the Brachiopoda (in Russian), 1874, pl. i. figs. 3, 10.

|| Mém. de l'Acad. de St. Pétersb. tome xvi. pls. i., vi. See also the above-cited memoir of Bobrezky's, pl. i. figs. 1-8.

¶ *Loc. cit.* p. 86.

\*\* *Loc. cit.* p. 64.

†† Van Beneden, *loc. cit.* p. 8; Delle Chiaje, Mem. 2nd edit. tome i. p. 40.

‡‡ *Loc. cit.* p. 93.

§§ *Loc. cit.* pp. 58, 67.

duction of the intestinal tract in *Sepiolo* from two opposite invaginations of the upper germ-lamella.

As regards the *body-cavity*, I think it will be most correct to give this name to the rather narrow and inconsiderable space which occurs between the peripheral layer of the dermo-muscular layer and one or two rows of the intestino-fibrous layer forming the muscular envelope of the intestinal tract. The whole of this completely closed body-cavity is bounded by elongated cells of the dermo-muscular layer forming the *peritoneum* or *peritoneal sac* (in which the alimentary apparatus, the central organs of the sanguiferous system, and subsequently also the generative organs are placed). The inner nutritive vitellus is never enclosed by a special bounding layer, as Kölliker \* thinks; but it lies free in the body-cavity, and the space occupied by it since the commencement of development represents the segmentation-cavity of the holoplastic ova with total segmentation of many other animals. The respiratory organs, the two branchiæ, and the funnel are situated in a special open *respiratory cavity* covered only by the ventral part of the mantle, and lined internally with simple epithelium forming the continuation of the upper germ-lamella, penetrating here during its separation from the ventral surface.

I have still to notice the period of the appearance of the nervous system and its mode of formation in the Cephalopoda. After a long series of frequently repeated observations relating to this question, and always furnishing the same results, I have been compelled to give up for ever the hope of finding, in the development of the nervous system of the Cephalopoda, any resemblance to its development in the Vertebrata, Tunicata, Annulosa, and Mollusca. Whilst even in many species belonging to the types of the Arthropoda and Mollusca some ganglia, at least (as has been proved †), are undoubtedly developed from the upper germ-lamella, all the ganglia of the Cephalopoda originate from more or less compact thickenings of the middle germ-lamella (dermo-muscular layer), and consequently in accordance with the mode of formation of the peripheral ganglia in the Vertebrata, which, indeed, has already been partially indicated by Metschnikoff ‡ with regard to

\* *Loc. cit.* pp. 61, 87, 167. Metschnikoff has justly rejected this view as regards *Sepiolo*.

† See the already cited remarkable memoir by Kowalevsky, *Mém. de l'Acad. de St. Pétersb.* tome xvi. p. 19, pl. v., and p. 24, pl. vii.; also Bobrezky's memoir, pl. iii.; M. Ganin, *Warschauer Universitätsberichte*, 1873, i.; and *Bericht für Anat. und Physiol.* 1873, p. 360.

‡ *Loc. cit.* pp. 41, 67.

*Sepiola.* After this preliminary remark I will now describe in a few words the sequence in which the ganglia make their appearance, their original form, and their original position in the Cephalopod embryo.

I have already mentioned the time of appearance of the paired *optic ganglia*. The cells of the middle lamella, which are at first few, but afterwards rapidly increase in number, from which the two oval aggregations (the rudiments of the above-mentioned ganglia) separate, are observable from the earliest appearance of the eye-ovals. At the close of the second period these large rudimentary ganglia placed at the sides of the broad quadrangular head of the embryo have the form of two irregular hemispheres, the convex surface of which closely approaches the retina, which is already becoming concave, whilst the flat sides are turned towards the rudiments of the *cerebral* and *visceral ganglia*. The first of these, the *cerebral ganglion*, which appears on the fifth day of the second period, likewise originates from two compact aggregations of cells of the dermo-muscular layer; and these are united by a broad but short commissure consisting of a few layers of similar cells. The rudiment of the originally paired cerebral ganglion, which is situated dorsally at the sides of the caecal rudiment of the oesophagus, constantly becomes broader and thicker with the development of the embryo; so that towards the end of the third period the commissure of the two halves, which was originally well defined, disappears, and the ganglion forms a rather large compact mass. Two paired compact aggregations of cells of the middle lamella, observable as early as the fourth day of the second period, which lie behind the rather distant rudiments of the auditory organs, divide gradually in the first half of the third period, to form the paired rudiments of the *pedal* and *visceral ganglia*. The two halves of the former grow rather rapidly; and in the second half of the third period, when the cephalic lobes approach each other, the united two form a crescentic ganglion, occupying the greater part of the anterior cephalic lobe, and lying above the auditory organs. Its upper part is on the same level as the buccal aperture, and somewhat higher than the opposite cerebral ganglion, which it touches with its sides.

The *visceral ganglion*, lying just behind this, consisting at first of two subsequently coalescent halves, is developed in the same manner. All the three above-mentioned originally paired ganglia (the cerebral, visceral, and pedal ganglia) gradually approach each other, and unite to form an oesophageal nerve-mass only towards the close of embryonic life. Their union takes place very slowly, keeping pace with the diminu-

tion of the nutritive vitellus which lies between them in the head and in the so-called neck. In the second half of the third period the paired rudiments of the superior and inferior *buccal ganglia* make their appearance on each side of the pharynx, composed of small spherical compact aggregations of cells of the middle lamella. At the same time and in the same manner originate the *ganglia stellata*, in the position in which they are found in adult Cephalopoda—and also the large spherical *ganglion splanchnicum*, which is situated between the stomach and the two halves of the liver.

The internal structure of all the above-mentioned ganglia begins to become differentiated soon after they make their appearance. In the central part of the ganglia, which at first consist of rounded homogeneous cells of the middle lamella, appears a dark, finely granular mass ("Punktsubstanz"), consisting of very fine variously intercrossed fibrillar threads—fine processes of the original cells of the middle lamella, now gradually being converted into small brown nerve-cells. As early as the close of the first half of the third period, especially in the peripheral part of the optic ganglia, in various parts of the cerebral ganglia, and subsequently also in all the other ganglia, we may distinctly observe the production both of the inner thin nerve-bundles serving as commissures to the different parts of the ganglia and of those running outwards (*e. g.* the broad but short optic nerves which unite the peripheral part of the optic ganglia with the retina). The peripheral nerves of the skin are developed towards the close of embryonic life independently of the ganglia, at the points which they afterwards occupy, from the elongated cells of the dermo-muscular layer, which unite with each other.

I have obtained all these briefly reported results chiefly by the comparative study of different sections belonging to different stages of development, a more or less accurate examination of the nervous system in living embryos being almost impossible on account of their opacity. As it is rather difficult without figures, to describe the various changes in the form and position of all the parts of the nervous system, I here conclude my description of that system, keeping the details for a more complete memoir with plates, which will soon appear.

In all the Cephalopoda investigated by me it is not alone the upper germ-lamella, as Metschnikoff thinks\*, but also, and, indeed, chiefly, the dermo-muscular layer of the middle lamella that is implicated in the formation of the different dermal layers. The skin begins to be differentiated in the first days of the third period (in *Loligo* and *Sepiola* approximately on the nineteenth, in *Argonauta* on the fourteenth or

\* *Loc. cit.* p. 37.

fifteenth day of development). The upper germ-lamella forms only the *epidermis*, composed of cylindrical, everywhere similar cells, covered in many places (especially on the mantle) in the rotating embryo with cilia. The outer, very thin layer of elongated cells of the dermo-muscular layer forms the so-called *fibrous layer*; whilst the *chromatophores*, and especially the *fibres of muscular and connective tissue* which lie in the *corium (cutis)*, are formed from the inner layers. The chromatophores originate in the first half of the third period, from large round, at first nucleated cells of the dermo-muscular layer. The coloured protoplasm of these cells shrivels at the time when a very thick membrane appears upon the cell; by this means the nucleus becomes invisible. Such newly formed chromatophores, appearing first on the mantle and afterwards on the head and arms, begin to contract when the cells radiately arranged round them stretch into a spindle-shape, and thus form the contractile muscular fibres long since described by Keferstein\* and Bohl†.

I do not consider it necessary to describe here the formation of the cartilage in its details, as all that I have observed with respect to it in *Sepia*, *Loligo*, and *Argonauta* agrees perfectly with the results obtained by Metschnikoff‡ in the case of *Sepiolo*. There is no doubt that all the cartilages differentiated in the third period (the cartilages of the cups, the eye-covers, the head, the fins, &c.) are developed from considerable thickenings (*e. g.* in the anterior cephalic lobe not far from the eyes) of the upper germ-lamella, at the spots where they are afterwards found in the adult animal.

With regard to the development of the paired *olfactory organ* of the Cephalopoda, which lies on the ventral side behind the eyes and appears towards the end of the third period (*Sepia*, *Loligo*, *Sepiolo*), originally in the form of a tubercle and then of a pit-like depression of the upper lamella, I can only confirm the observations of Kölliker§, Metschnikoff||, and Tschernoff¶.

With this I conclude the exposition of the results of my investigations of the development of the four above-mentioned species of Cephalopoda, which lasted uninterruptedly almost two years. At present engaged in extending and completing these studies, I hope soon to be able to publish a more detailed memoir.

[To be continued.]

\* Bronn's Klassen und Ordn. Bd. iii. Abth. ii. p. 1324.

† Beitr. zur vergl. Histol. p. 70, pl. iii. figs. 40 & 41.

‡ *Loc. cit.* pp. 39 *et seq.* § *Loc. cit.* pp. 107 *et seq.*

|| *Loc. cit.* p. 53.

¶ Bull. Soc. Imp. Nat. Mosc. 1869, p. 87, pl. i.

XXIX.—On some new Species of Butterflies from Tropical America. By ARTHUR GARDINER BUTLER, F.L.S., F.Z.S., &c.

THE following species are chiefly interesting additions to our knowledge of the Rhopalocerous fauna of Veragua, the *Antirrhæa* and *Daptonura* being most valuable, on account of the limited number of species in both genera hitherto recorded.

### Family Nymphalidæ.

#### Subfamily SATYRINÆ, Bates.

#### Genus ANTIRRHÆA, Westwood.

##### 1. *Antirrhæa tomasia*, n. sp.

Allied to *A. miltiades*; primaries above more like *A. philaretetes*, the transverse discal bar being indistinct; secondaries darker in the male, rather paler in the female, with one small subapical white dot, no other markings; fringe sordid, not bright yellow as in *A. miltiades*: wings below almost as in *A. philaretetes*, but richer in colour; the central band broader and more strongly angulated in secondaries than in any known species; its external whitish marginal bar much narrower, scarcely indicated from the costa of secondaries to the third median branch, but wide and continuous from the first branch to the anal angle; the ocelliferous patch on median interspaces chiefly differing from that of *A. philopæmen* in consequence of the encroachment of the angular outer edge of the central band; external border tinted with tawny.

Expanse of wings, ♂ 3 inches 9 lines, ♀ 4 inches 3 lines.

*Hab.* Bugaba, Veragua. Type, coll. H. Druce.

#### Subfamily NYMPHALINÆ, Bates.

#### Genus PAPHIA, Fabricius.

##### 2. *Paphia Ada*, n. sp.\*

Wings above blue-black, with brighter blue gloss at base; primaries with a pale greenish-blue maculated band (composed of seven spots), angulated near apex, running from the third fifth of the subcostal nervure to the end of the submedian; secondaries with the costal area black-brown; abdominal area pale rosy brown, clothed along submedian nervure and towards anal angle with long dark brown hairs: body above greenish black: wings below very similar to *P. maris*, but without the tail, chocolate-brown, sericeous, hatched and banded with dull



brown and irrorated with dead silver; primaries with outer margin and an oblique streak to apex silver; secondaries with a submarginal series of five silver dots near anal angle: legs and palpi below pepper-and-salt colour.

Expanse of wings 2 inches 8 lines.

*Hab.* Bugaba, Veragua, and Bogota (*Lindig*). Type, coll. Druce.

There is an example of this species in the collection of the British Museum from Bogota. The species is allied to *P. xenocrates*, but much smaller, the primaries above being more like *P. psammis*.

### 3. *Paphia rutilans*, n. sp.

Wings above glossy magenta-red, with blue reflections; primaries with apical half from basal third of costa to external angle sepia-brown, partly shot with blue, crossed near apex by a short, irregular, oblique magenta band (not reaching costa or outer margin); a lunulated dark brown bar from third median branch at its basal third to third fifth of submedian nervure; secondaries with costa, apex, a lunate spot near apex, and outer margin sepia-brown; abdominal area pale brown; body olive-brown: wings below red-brown, hatched all over with grey, clouded, spotted, and banded with dark brown, as in *P. centaurus*; secondaries with four minute white anal submarginal dots: body whitly brown, speckled with red-brown.

Expanse of wings 2 inches 6 lines.

*Hab.* Pucartambo, Peru (*Whitely*). Type, B.M.

Coloured much like *P. centaurus*, but more like *P. ryphea* in form, size, and pattern.

Subfamily *HELICONINÆ*, Bates.

Genus *HELICONIUS*, Fabricius.

### 4. *Heliconius clarescens*, n. sp.

Closely allied to *H. telchinia*, but differing in the restriction of the discoidal black streak of primaries to a short oblique spot above the origin of the first median branch, the absence of the internal streak, the yellow tint at termination of the fulvous area, and the absence of the black elliptical band of secondaries; wings below with the same differences.

Expanse of wings 3 inches 8 lines.

*Hab.* Bugaba, Veragua. Type, coll. Druce.

Probably a mimic of *Mechanitis macrinus*.

5. *Heliconius superioris*, n. sp.

Nearly allied to *H. numata*, but with the yellow band of primaries tinted externally with tawny, the two spots on median interspaces and the streak from outer margin (at end of yellow band) united together; discoidal spot and streak enlarged, sometimes connected; tawny macular discal bar narrower; marginal border wider, dotted with buff: differences below as above, excepting that the secondaries have the usual submarginal row of white dashes.

Expanse of wings 3 inches 3-7 lines.

*Hab.* Ega and Villa Nova (*Bates*). Type, B.M.

This species is intermediate in character between *H. numata* and *H. metalilis*.

6. *Heliconius nubifer*, n. sp.

Differs from the preceding in having all the tawny area clouded with mahogany-colour, with the black bars wider; no yellow spot on under surface of secondaries.

Expanse of wings 3 inches 1 line.

*Hab.* Fonteboa (*Bates*). Type, B.M.

One of the many mimics of *Mechanitis egaensis* of *Bates*.

## Family Papilionidæ.

Subfamily PIERINÆ, *Bates*.

Genus DAPTONURA, *Butler*.

7. *Daptonura florinda*, n. sp.

♂. Wings above sulphur-yellow; the apex, outer margin and costa of primaries (excepting a pyriform spot at base), and the outer margin of secondaries narrowly black: head black, clothed with grey and cream-coloured hairs; thorax grey, scantily clothed at the sides with pale yellow hairs; abdomen sulphur-yellow, greyish towards base: wings below deeper yellow than above, margins paler brown; primaries with a discocellular transverse streak, widening upon the costa; four apical submarginal yellow spots; secondaries with the base orange; pectus orange at the sides, anal valves white.

Expanse of wings 2 inches 9 lines.

♀. Primaries gamboge-yellow, with the base and internal area diffusely saffron, an oblique discocellular brown streak; outer margin more broadly brown than in the male, and

sinuated internally; secondaries saffron-yellow, with a wider brown border; body tinted with saffron; otherwise as in the male: primaries below almost as in the male, but with six marginal yellow spots; secondaries saffron-yellow, with a broader brown border.

Expanse of wings 2 inches 9 lines.

*Hab.* Bugaba, Veragua. Type, coll. Druce.

Var. ? *monstrosa*.

♂. Smaller and altogether paler than the preceding; primaries above white, the apex with a broader and more strongly sinuated black-brown border; secondaries yellowish white, becoming sulphur-yellow close to the margin, which has a broader border than in the preceding species; primaries below also paler, excepting at apex, with no apical yellow spots, and a more slender discocellular bar; secondaries with broader marginal border and with the orange confined to the base of costa.

Expanse of wings 2 inches 6 lines.

*Hab.* Bugaba, Veragua. Type, coll. Druce.

The above may turn out to be distinct from *D. florinda*. It is not only smaller and different in coloration, but the primaries are narrower and their outer margin is more distinctly incurved. Both forms approach *D. isandra* in form and marking; but in the ground-colour of the wings *D. florinda* ♂ is like *D. polyhymnia*, *D. florinda* ♀ more like *D. leucanthe* ♀, and var. ? *monstrosa* like *D. pantoporia* ♂.

## PROCEEDINGS OF LEARNED SOCIETIES.

### ROYAL SOCIETY.

December 17, 1874.—Joseph Dalton Hooker, C.B., President, in the Chair.

“Preliminary Note upon the Brain and Skull of *Amphioxus lanceolatus*.” By T. H. HUXLEY, Sec. R.S.

The singular little fish *Amphioxus lanceolatus* has been universally regarded as an extremely anomalous member of the Vertebrate series, by reason of the supposed absence of renal organs and of any proper skull and brain. On these grounds, chiefly, Agassiz proposed to separate it from all other fishes; and Haeckel, going further, made a distinct division of the Vertebrata (*Acrania*)

for its reception; while Semper\*, in a lately published paper, separates it from the Vertebrata altogether.

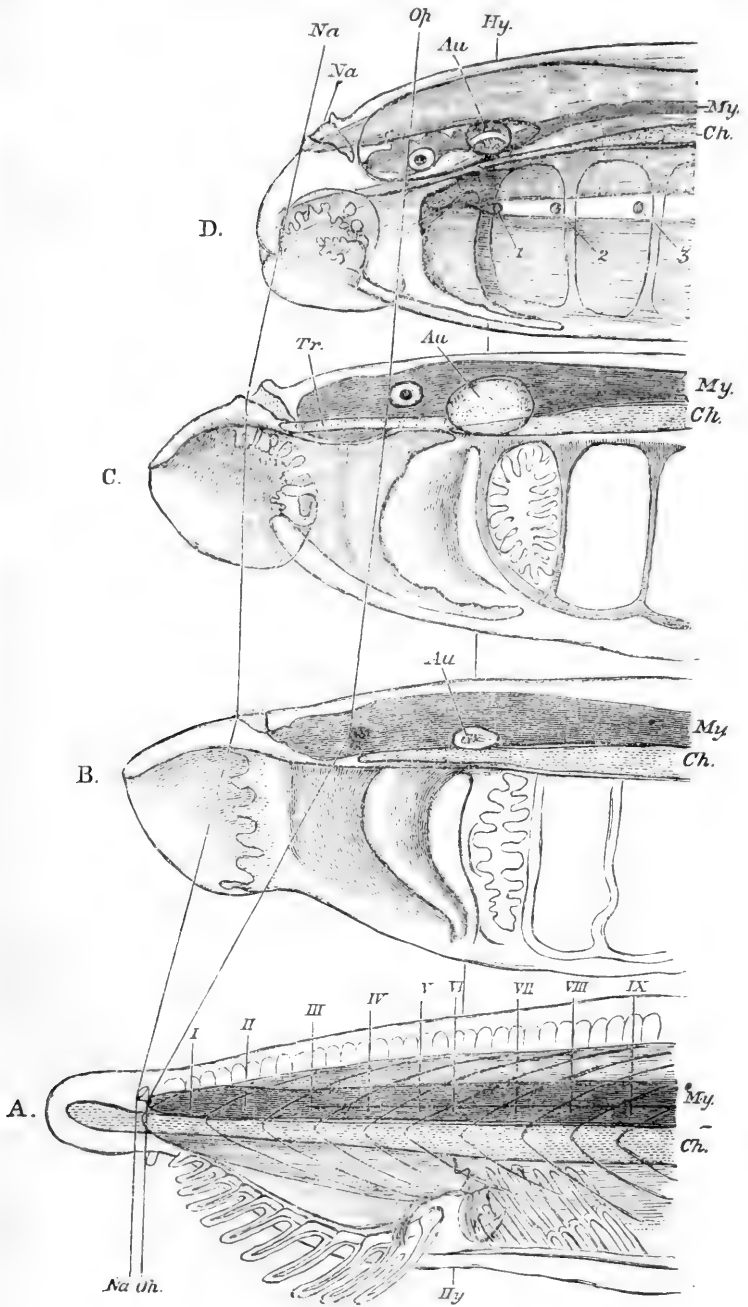
In a recent communication to the Linnean Society, I have described what I believe to be the representative of the ducts of the Wolffian bodies, or "primordial kidneys" of the higher Vertebrata, in *Amphioxus*; and I propose, in this preliminary notice, to point out that although *Amphioxus* has no completely differentiated brain or skull, yet it possesses very well-marked and relatively large divisions of the cerebro-spinal nervous axis and of the spinal column, which answer to the encephalon and the cranium of the higher Vertebrata.

The oral aperture of *Amphioxus* is large, of a long oval shape, and fringed by tentacles, external to which lies a lip, which is continuous behind with the ventro-lateral ridge of the body. The oral chamber is spacious, and extends back to the level of the junction between the sixth and seventh myotomes (fig. A). Here it is divided from the branchial cavity by a peculiarly constructed, muscular *velum palati*, the upper attachment of which to the ventral aspect of the sheath of the notochord lies vertically below the anterior angle of the seventh myotome.

Eight pairs of nerves are given off from the cerebro-spinal axis as far as this point. The eighth, or most posterior, of these, which, for convenience, may be called *h*, passes out between the sixth and seventh myotomes, and runs down parallel with the lateral attachment of the velum. The next five (*g, f, e, d, c*) pass out between the first six myotomes, and are distributed by their dorsal and ventral branches to those myotomes, to the integument, and to the walls of the buccal cavity. The foremost two nerves (*b* and *a*) pass in front of the first myotome; and the nerve *a* runs parallel with the upperside of the notochord to the end of the snout, giving off branches to that region of the body which lies in front of the mouth. This nerve lies above the eyespot.

In the Marsipobranch fishes *Myxine* and *Ammocetes* (now known to be a young condition of *Petromyzon*) a velum also separates the buccal from the branchial cavity (figs. B, C, D). But this velum is in connexion with the hyoidean arch. The resemblance of the buccal cavity, with its tentacles, in *Ammocetes* to the corresponding cavity in *Amphioxus* is so close, that there can be no doubt that the two are homologous. In the *Ammocetes* there is a hyoidean cleft which has hitherto been overlooked. The auditory sac lies at the dorsal end of the arch and above the dorsal attachment of the velum. The latter, therefore, corresponds with the auditory region of the skull; and the nerve *h* should answer to the last of the preauditory cranial nerves, which is the *portio dura*. Assuming this to be the case, though the detailed homologies of the cranial nerves of the higher Vertebrata are yet to be worked out, it follows that the segment of the cerebro-spinal axis which in *Amphioxus*

\* "Die Stammerwandtschaft der Wirbelthiere und Wirbellosen," Arbeiten aus dem zool.-zootom. Institut in Würzburg, Bd. ii. 1874, p. 42.



lies between the origin of the nerve *h* and the eye, answers to all that part of the brain which lies between the origin of the seventh nerve of *Petromyzon* and the optic nerve. Consequently the lateral walls of the neural canal in the same region answer to that region of the skull in *Petromyzon* which lies between the origin of the seventh and the origin of the optic nerve. Hence, as each myotome of *Amphioxus* represents the corresponding portion of a protovertebra, it follows that the same region of the skull in the Lamprey and other Vertebrata represents, at fewest, six protovertebrae, almost all traces of which are lost, even in the embryo condition of the higher Vertebrata.

It may further be concluded that the several pairs of nerves which leave the cerebro-spinal axis, between those which answer to the *portio dura* and the optic nerve, in *Amphioxus*, are represented by the third, fourth, fifth, and sixth pairs of cranial nerves of the higher Vertebrata. The nerve *a*, in fact, has the characteristic course and distribution of the orbito-nasal division of the trigeminal; while, without at present drawing a closer parallel, it is easy to see that the nerves *b, c, d, e, f,* and *g*, with their respective myotomes, supply the requisite materials for metamorphosis into the oculomotor, pathetic, trigeminal, and abducens nerves, with the muscles of the eye and of the jaws, in the more differentiated vertebrate types.

Thus that part of the cerebro-spinal axis of *Amphioxus* which lies in front of the seventh myotome answers to the præauditory part of the brain in the higher Vertebrata, and the corresponding part of the head to the trabecular region of the skull in them. On the other hand, from the seventh myotome backwards, a certain number of segments answer to the postauditory, or parachordal, region of the skull of the higher Vertebrata.

The answer to the question, how many? involves sundry considerations. It must be recollected that though the branchial chamber of *Amphioxus* is the homologue of the branchial chamber of other Vertebrata, it does not necessarily follow that the imperfect branchial skeleton of *Amphioxus* corresponds with their branchial skeleton. The branchial skeleton of the higher Vertebrata consists of cartilaginous rods, which seem to be developed in the somatopleure, and to be homologous with the ribs, while the branchial skeleton of *Amphioxus* consists of fibrous bands apparently developed in the splanchnopleure.

The branchial arches of the higher Vertebrata, in accordance with their essentially costal nature, receive their innervation from the glosso-pharyngeal and pneumogastric nerves, which are homologues of spinal nerves; and, in seeking for the posterior limits of that region in *Amphioxus* which corresponds with the skull and brain in other Vertebrates, we must only take into account as many pairs of those nerves which arise from the cerebro-spinal axis as we know are, in the Vertebrata next above *Amphioxus*, devoted to the branchial arches. In none of these are there more than seven pairs of branchial arches; so that not

more than eight myotomes (and consequently protovertebræ) of *Amphioxus*, in addition to those already mentioned, can be reckoned as the equivalents of the parachordal region of the skull in the higher Vertebrates. Thus it would appear that the cranium of the latter is represented by those segments of the body of *Amphioxus* which lie in front of the fifteenth, counting from before backwards, and that their cranial nerves are represented by the corresponding anterior pairs of nerves in *Amphioxus*.

In all Vertebrata above *Amphioxus* the nerves which answer to the seven posterior pairs in *Amphioxus* unite into one or two trunks on each side, and give rise to the nerves called pneumogastric and glosso-pharyngeal; and as these pass out of the skull in front of the occipital segment, it would appear that this segment is, in the main, the result of the chondrification, with or without subsequent ossification, of the fourteenth protovertebra.

There is no evidence, at present, that the ear-capsule represents a modification of any part of the vertebral skeleton, nor that the trabeculæ are any thing but an anterior pair of visceral arches. And if these parts have nothing to do with centra, or arches, of vertebræ, it follows that the numerous protovertebræ which lie in front of the fourteenth in *Amphioxus*, are represented only by muscles and nerves in the higher Vertebrata.

The anterior end of the cerebro-spinal axis of *Amphioxus* answers to the *lamina terminalis* of the thalamencephalon of the higher Vertebrata, the cerebral hemispheres and olfactory lobes remaining undeveloped.

If the auditory nerve is, as Gegenbaur has suggested, the dorsal branch of a single nerve which represents both the *portio dura* and the *portio mollis*, the auditory organ of *Amphioxus* is to be sought in connexion with the dorsal branch of its eighth nerve. I have found nothing representing an auditory organ in this position; and I can only conclude that *Amphioxus* really has no auditory apparatus. In all other respects, however, it conforms to the Vertebrate type; and, considering its resemblance to the early stages of *Petromyzon* described by Schultze, I can see no reason for removing it from the class Pisces. But its permanently segmented skull and its many other peculiarities suggest that it should be regarded as the type of a primary division or subclass of the class Pisces, to which the name of *Entomocrania* may be applied, in contrast to the rest, in which the primary segmentation of the skull is lost, and which may be termed *Holocrania*. On a future occasion I propose to show in what manner the skull of the Marsipobranch is related to that of the higher Vertebrata, and more especially to the skull of the Frog in its young tadpole state.

#### EXPLANATION OF THE FIGURES.

A, C, D are diagrammatic, but accurate, representations of the anterior part of the body in *Amphioxus* (A), in an *Ammocate* 1·6 inch long (C), and in a fully grown *Ammocate* 5·7 inches long (D). B is a copy of the  
*Ann. & Mag. N. Hist.* Ser. 4. Vol. xv. 16

furthest advanced stage of the young *Petromyzon Planeri* six weeks after hatching, as figured by Schultze in his memoir on the development of that fish. The figures are magnified to the same vertical dimension, so as to afford a means of estimating, roughly, the changes in the proportional growth of the various parts of the head of the Lamprey in its progress from the embryonic towards the adult condition. In C, the brain is already differentiated into the three primary vesicles and the vesicles of the cerebral hemispheres, though they are not shown, the whole brain being merely indicated by the dark shading. The trabeculae (*Tr*), which have already united in front, are indicated, but not the semilunar ethmoidal cartilage, which lies above and behind the nasal sac. In D, neither the ethmoidal nor the trabecular cartilages are shown, but the contour of the brain is indicated; and the manner in which the longitudinal muscles (which represent the anterior myotomes of *Amphioxus*) are arranged is shown. The tentacles of *Amphioxus* are represented by the tentacles of the *Ammocete*, the hood-like "upper lip" of the latter obviously answering to the median prolongation of the head of *Amphioxus* with the two lateral folds of integument which lie outside the bases of the tentacles and are continued back into the ventro-lateral ridges. The relative shortening of the notochord, and lengthening of that region of the brain which lies in front of the origins of the optic nerves, in C, as compared with B, is remarkable.

A line is drawn in all the figures through the anterior margin of the nasal sacs (*Na-Na*); another has the same relation to the eyes (*Op-Op*); and a third (*Hy-Hy*) passes through the region of the auditory sac and hyoidean arch. 1, 2, 3, hyoidean and first and second branchial clefts of *Ammocetes*; I, II, III, IV., &c., myotomes of *Amphioxus*; *My*, myelon or spinal cord; *Ch*, notochord.

## MISCELLANEOUS.

*On the Gammaridæ of Lake Baikal.* By Dr. B. N. DYBOWSKY.

THIS memoir reveals to us the existence in Lake Baikal of an Amphipodous fauna remarkable for an abundance and variety of specific forms such as we certainly had no reason to expect.

Gerstfeldt, in a memoir published in 1858, described seven species of *Gammarus* found in different rivers of Siberia and in Lake Baikal. From what we know of freshwater faunas there was not much reason to suppose that this number would be greatly augmented; but Dr. Dybowsky now makes known 97 species of Gammaridæ, nearly all of which are new. They come almost exclusively from Lake Baikal, only a few of them in summer ascending the mouths of its tributaries; and there are very few which permanently inhabit the rivers.

We do not think that any region of the globe has furnished a contingent of freshwater Amphipoda which approaches this in number of species. It is curious, for example, to compare the fauna of Siberia, in this respect, with that of Norway, which we know from the fine memoir of G. O. Sars\*. In Norway the freshwater Gammaridæ are represented only by four species; that is to say, they are only one twenty-fourth the number of those of Lake

\* G. O. Sars, 'Histoire Naturelle des Crustacés d'eau douce de Norvège: Malacostracés.' Christiania, 1867.



Baikal. One of the Scandinavian species, *Gammarus (Pallasea) cancelloides*, occurs also in Siberia; another, *Gammarus neglectus*, is scarcely distinct from *Gammarus pulex*, which forms part of the fauna of Lake Baikal. If we compare the relative number of genera admitted by the two authors, we find a remarkable difference; thus Dr. Dybowsky only admits two genera for his 97 species (*Gammarus* 96 species, *Constantia*, g. n., 1 species), while the four species of M. Sars belong to four different genera. But the genus is something much more subjective than the species; and we have no doubt that, if treated by some authors (Mr. Spence Bate, for example), the Gammaridæ of Lake Baikal would have furnished materials for the creation of numerous generic groups. *Gammarus cancelloides*, Gerstf., retained by Dr. Dybowsky in its original genus, is the *Pallasea cancelloides* of Spence Bate and Sars.

Dr. Dybowsky explains the reason why he has not dismembered the genus *Gammarus*—namely, that the modifications observed in the different parts of the body present numerous gradations which bind together the most extreme forms into one whole. It may also be observed that the gradual transitions presented by each group of organs or each part have no correlations with those detected in other parts of the organism. In the most widely separated species we find a similar structure of certain parts, which, on the other hand, are very dissimilar in nearly allied species. There is a sort of interlacing of characters which only allows of the establishment of artificial sections, and justifies, it seems to us, the course followed by the author.

The only new genus, which he has named *Constantia*, is distinguished by the structure of its two pairs of antennæ, which are modified so as to form locomotive organs. Their flagella are destitute of sensory organs, and furnished with two rows of long, rigid setæ, which give them a plumose appearance. There is no appendicular flagellum. All the legs are long and slender, especially the second pair of walking-feet (fourth pereopoda) and the first pair of jumping-feet. The only species belonging to the genus (*C. Branickii*) does not keep at the bottom like the *Gammari*; it is pelagic, and, like other surface Crustacea, has a completely transparent body, so that it can only be perceived in the water in consequence of its black eyes. In reading what the author says of it, it is impossible not to think of *Cystosoma Neptuni*, another almost perfectly transparent Amphipod, which leads a pelagic existence in the Atlantic and Indian Oceans.

Notwithstanding the gradual modifications which they present in their different organs, the Siberian species of the genus *Gammarus* are sufficiently distinct from each other in their general characters; indeed a considerable number are remarkable for their forms, proportions, or ornaments. Some comparatively gigantic species attain a total length of from 118 to 120 millims. (nearly 5 inches); but the small species are much more abundant, and there are even dwarfish forms of which the total length does not exceed 7 or 8 millims.

All depths of the lake have furnished Gammaridæ. The greatest depth to which the author has hitherto carried his dredgings, namely 1373 metres, proved to be as well peopled as the littoral zone, although the number of species was less than at higher levels. However, this comparative poverty seems to be attributable to the fact that the exploration of great depths is attended with great difficulties. Dr. Dybowsky has no doubt that more regular investigations carried on between 500 and 1300 metres would be recompensed by the discovery of new species.

Most of the Gammaridæ of Lake Baïkal which live at small depths are vividly coloured; but with the increase of depth the coloration gradually diminishes, and the species living below 700 metres are more or less whitish in tint. Some varieties, coming from greater depths than those inhabited by the specific type, are distinguished by the paleness of their bodies and eyes, and also, in some cases, by the more elongated and slender form of their locomotive appendages.—*Horæ Soc. Ent. Ross. Bd. x. Supplement; Bibl. Univ., Bull. Sci. 1874, p. 372.*

*On the Mode in which Amœba swallows its Food.*

By Prof. J. LEIDY.

The author remarked that he had supposed that *Amœba* swallows food by this becoming adherent to the body and then enveloped, much as insects become caught and involved in syrup or other viscid substances. He had repeatedly observed a large *Amœba*, which he supposes to be *A. princeps*, creep into the interstices of a mass of mud and appear on the other side without a particle adherent. On one occasion he had accidentally noticed an *Amœba* with an active flagellate infusorium, a *Urocentrum*, included between two of its finger-like pseudopods. It so happened that the ends of these were in contact with a confervous filament; and the glasses above and below, between which the *Amœba* was examined, effectually prevented the *Urocentrum* from escaping. The condition of imprisonment of the latter was so peculiar that he was led to watch it. The ends of the two pseudopods of the *Amœba* gradually approached, came into contact, and then actually became fused—a thing which he had never before observed with the pseudopods of an *Amœba*. The *Urocentrum* continued to move actively back and forth, endeavouring to escape. At the next moment a delicate film of the ectosarc proceeded from the body of the *Amœba*, above and below, and gradually extended outwardly so as to convert the circle of the pseudopods into a complete sac, enclosing the *Urocentrum*. Another of these creatures was noticed within the *Amœba*, which appeared to have been enclosed in the same manner.

This observation would make it appear that the food of the *Amœba* ordinarily does not simply adhere to the body, and then sink into its substance, but rather, after becoming adherent to or covered by the pseudopods or body, is then enclosed by the active extension of a film of ectosarc around it.—*Proc. Acad. Nat. Sci. Philad. p. 143.*

*On the Discovery of true Batrachians in Palæozoic Rocks.*

By M. A. GAUDRY.

Hitherto Batrachians of existing types seemed to be of recent geological date; most palæontologists believed that these animals did not occur in any formations more ancient than the Tertiaries. There was some ground for astonishment that Vertebrata of such low organization should have come upon the earth so late; and this fact seemed to be in opposition to most of those which palæontology has registered.

I have the honour to bring before the Academy some remains of Batrachians which have just been discovered in Palæozoic rocks. One of them was communicated to me some months since by M. Loustau, engineer on the Northern Railway; it was collected by M. Roche in the bituminous schists of Permian age at Igornay (Saône-et-Loire). A few days ago M. François Delille brought me a slab upon which may be seen seven little Batrachians, which closely resemble those of Igornay. He obtained it at Millery (Saône-et-Loire); and, like the specimen from Igornay, this slab was procured from bituminous schists of Permian age.

I propose to give the Batrachians of Igornay and Millery the name of *Salamandrella petroli*, to indicate that they have affinities with the salamanders, and to note that they have been buried in deposits from which petroleum is extracted. They are very small: the individual communicated to me by M. Loustau is 30 millims. in length from the outer edge of the muzzle to the extremity of the tail; and the largest of the individuals found by M. Delille is only 35 millims. Notwithstanding their small size, it is probable that they were adult; for the heads, tails, and limbs of the different examples are clearly of the same proportions. The heads are broader than long, triangular, and much flattened: as not one of them is placed on its side, I think that this flattening is natural and not merely the result of the compression of the beds. The orbits are very large and elongated; we see no place for the postorbitals and suprasquamosals, which are so much developed in the Ganocephali. The vertebræ have the centrum ossified: I count 29 of them, viz. 3 cervical, 10 dorsal, 8 lumbar, and 8 caudal, the last very much reduced. The cervical and dorsal vertebræ have arched ribs, much shorter than those of the Ganocephali. I have not been able to perceive any indications of the entosternum and episterna, so remarkable in the Ganocephali and Labyrinthodonts. The fore and hind limbs are nearly of the same size; both are furnished with four digits. I see no traces of scales which could be attributed to the *Salamandrella*; and, indeed, I cannot distinguish around the skeleton any deposit or coloration indicating a hardened skin, which would have persisted longer than the other soft organs.

One cannot help being struck by the resemblance of the little Batrachians of Igornay and Millery to the terrestrial salamanders. Nevertheless their head is a little broader; the bones of their limbs seem to have had the extremities less well-defined; the hind limbs

are directed backward, as in swimming animals. The dorsal and lumbar vertebrae are shorter and more numerous; the lumbar vertebrae bear no ribs; the tail represents only one fifth of the whole length of the body, whilst in the salamanders it equals nearly the half.

The *Salamandrella* is very distinct from the reptiles of the Carboniferous formation which have been described under the names of Labyrinthodonts, Ganocephali, and Microsaurians (such as *Dendroperpeton*, *Hylorpeton*, *Hylonomus*, *Parabatrachus*, *Anthraxerpeton*, *Urocordylus*, *Ceraterpeton*, *Sauroploera*, *Molyophis*, &c.); but it differs less widely from *Raniceps* (*Pelion*) *Lyelli* from Ohio.

Now that the existence of true Batrachians in the Palaeozoic rocks seems to be proved, probably no difficulty will be raised to placing *Raniceps* among those animals, as was proposed by Mr. Wyman in 1858. It is probable that *Raniceps* had a naked skin, and that it possessed no entosternum, episternum, postorbital, or subsquamosal. Nevertheless it cannot belong to the same genus as the fossils of MM. Loustau and Delille; its vertebrae are much more elongated, its frontals are less widened, the supraoccipital is thrown less backwards, and its mandibles are more prolonged. Lastly, the animal from Ohio is three times as large.

In 1844 Hermann von Meyer described, under the name of *Apaton pedestris*, the impression of a reptile found in the Carboniferous formation of Münster-Appel. Notwithstanding the opinion of this talented palaeontologist, I think that it belonged to an animal of the group of salamanders; and if it were allowable to form a judgment from an impression so vague as that of *Apaton*, I should be inclined to believe this fossil to be identical with *Salamandrella petrolei*. Thus we should be acquainted with true Batrachians in the Palaeozoic rocks of France, the United States, and Germany.

The bituminous schists which contain *Salamandrella petrolei* also include remains of plants, numerous coprolites, and fishes (*Palæoniscus*). M. Loustau has communicated to me a small crustacean derived from them, a series of well-ossified vertebrae of a still unknown reptile, and a fragment of a humerus or femur agreeing in size with that of *Actinodon Frossardi*, a curious Ganocephalous reptile, also collected in the bituminous schist, at Muse, not far from Igornay and Millery, which I brought before the Academy in 1866.

To complete the list of Palaeozoic reptiles found in France, I must remark that M. Paul Gervais has described a reptile from the Permian schists of Lodève under the name of *Aphelosaurus*; that learned naturalist has shown that it is very distinct from the Batrachians.—*Comptes Rendus*, February 15, 1875, p. 441.

#### *On the Motive Power of Diatoms.* By Prof. J. LEIDY.

While the cause of motion remains unknown, some of the uses are obvious. The power is considerable, and enables these minute organisms, when mingled with mud, readily to extricate themselves and rise to the surface, where they may receive the influence of

light and air. In examining the surface-mud of a shallow rain-water pool, in a recent excavation in brick-clay, the author found little else but an abundance of minute diatoms. He was not sufficiently familiar with the diatoms to name the species; but it resembled *Navicula radiosa*. The little diatoms were very active, gliding hither and thither, and knocking the quartz-sand grains about. Noticing the latter, he made some comparative measurements, and found that the *Navicule* would move grains of sand as much as twenty-five times their own superficial area, and probably fifty times their own bulk and weight, or perhaps more.—*Proc. Acad. Nat. Sci. Philad.* p. 113.

*On the Peripheral Nervous System of the Marine Nematoids.*

By M. A. VILLOT.

The marine Nematoids possess well-characterized organs of sense, consisting:—1, of organs of touch, represented by numerous setæ or papillæ distributed over the whole surface of the body, but particularly abundant round the head and the genital orifice; 2, of an apparatus of vision, composed of two eyes, of rather complex structure, situated on the dorsal surface towards the anterior extremity. The nature of these different organs ought not to be doubtful; but the fact is that their relations with the nervous system have hitherto been very obscure. According to M. Marion\* nervous filaments penetrate obliquely “into the midst of the longitudinal muscles to arrive soon at a fusiform, nucleolated cell, itself situated at the base of a cuticular hair, and united with this hair by another nervous thread which terminates at the base of the hair.”

M. Bütschli, whose memoir is very recent†, has figured an analogous arrangement; but he states that he has not detected the fusiform cell described by the French writer. He expresses himself as follows:—“Marion states with regard to his *Thoracostoma setigerum*, that a little before the entrance into the setule a fusiform cell is interposed in each of these filaments; with the exception of gangliiform dilatations, which, however, seem to me to have no regular occurrence, I have detected nothing which could be interpreted in favour of this observation.”

In presence of these contradictory assertions it became necessary to undertake fresh researches, and to subject those which had been made to the check of the experimental method. Hence my attention was directed most particularly to this point when, in the month of May last, I commenced my investigation of the Helmintha of our shores, in the laboratory of Professor de Lacaze-Duthiers. Now it appears from my numerous observations made at Roscoff upon living individuals, and repeated at Paris upon my preparations, that the two naturalists whom I have just cited have been deceived by false

\* “Additions aux recherches sur les Nématoides libres du Golfe de Marseille,” *Ann. Sci. Nat. Zool.* 5<sup>e</sup> série, tom. xix. p. 13, pl. xx. fig. 1.

† *Zur Kenntniss der freilebenden Nematoden, insbesondere der des Kieler Hafens*, p. 8, pl. iv. fig. 19, b (1874).

appearances, due probably to compression, and that they have not seen the true arrangement of the peripheral nervous system of these little creatures. As this arrangement is really very remarkable, I shall now give a short description of it.

Beneath the cuticle, which is smooth or striated, but always structureless, we find a very thin and very refractive granular layer. This layer has neither been figured nor described by M. Marion; but Dr. Charlton Bastian\*, in 1866, indicated it very clearly, and even recognized that it contained cells. To investigate it properly it is necessary to macerate entire worms in a mixture of acetic acid, alcohol, glycerine, and water—a mixture which has already rendered me great service in many cases, and the formula of which I have given in my 'Monographie des Dragonneaux.' The marine Nematoids, when immersed in this liquid, quickly became perfectly transparent. We can then see very distinctly that the granular layer situated between the skin and the muscles consists in great part of very fine fatty granules, and that it contains, scattered through it, small stellate cells furnished with a very refractive nucleus.

The relations of these little cellular bodies to the setæ or papillæ are easily ascertained. In a longitudinal section we perceive very distinctly that from the apex of each cell, perpendicularly to the axis of the animal, issues a very delicate thread which, after having traversed the whole thickness of the cuticle, arrives at the base of the papilla and enters it: but each cell also furnishes laterally a certain number of processes which place it in relation with the neighbouring cells; and it is equally easy to ascertain this, if, instead of making a section of the animal, we endeavour to follow the granular layer over a certain portion of its surface, by gradually raising the object-glass of the microscope. The subcutaneous layer of the marine Nematoids, therefore, contains a true network of ganglionic cells, which furnish nervous threads both to the organs of touch and to the organs of vision. This peripheral network is in relation with the central nervous system by means of a plexus, which traverses the muscular layer and unites the ventral nerve with the subcutaneous layer.

These are undoubtedly facts of detail and of delicate observation; but still they are of importance, for they are not isolated. It will suffice for me to recall that various observers have indicated a very analogous network in the Actiniæ, and that I have myself described one exactly similar in *Gordius*. This network arrangement of the ganglionic cells is certainly less rare in the Invertebrata than has hitherto been supposed; and it is probable that it represents in itself the whole of the nervous system of inferior types.—*Comptes Rendus*, February 8, 1875, p. 400.

\* "On the Anatomy and Physiology of the Nematoids, parasitic and free," *Phil. Trans.* 1866, vol. clvi. part 2, pl. xxviii. fig. 36, *d*.

# THE ANNALS

AND

## MAGAZINE OF NATURAL HISTORY.

[FOURTH SERIES.]

No. 88. APRIL 1875.

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XXX.—*On the Structure and Systematic Position of the Genus Cheirolepis.* By R. H. TRAQUAIR, M.D., F.G.S., Keeper of the Natural-History Collections in the Edinburgh Museum of Science and Art.

[Plate XVII.]

THIS very interesting genus of Devonian fishes was originally described by the late Prof. Agassiz, in the second volume of his 'Poissons Fossiles,' p. 178, and was then included by him in his family of "Lepidoides." The first step towards the breaking-up of that heterogeneous assemblage was taken by Agassiz himself, in the course of the publication of the same great work, when he constituted the family of Acanthodidæ for the genera *Cheiracanthus*, *Acanthodes*, and *Cheirolepis*; and this classification was retained in his special work on the Fossil Fishes of the Old Red Sandstone. The founder of fossil ichthyology seems, however, to have had but a slight and not very correct conception of the structure of the fishes with which he associated *Cheirolepis*, as may be seen both from his restored figures and his remark that, as the bones which he had been able to distinguish in *Cheirolepis*, "such as the frontal, humerus, temporal, have the same structure as in ordinary osseous fishes," one may conclude "that the Acanthodians in general had a complete osseous system, and not merely a *chorda dorsalis* as in the *Cocosteï* and other fishes of the same epoch"\*. Subsequent investigations into

\* Poissons Fossiles du vieux Grès Rouge, p. 44.  
*Ann. & Mag. N. Hist.* Ser. 4. Vol. xv. 17

the structure of the true Acanthodidæ have long since shown that this generalization was rather hasty. *Cheirolepis*, however, he considered as forming, by the absence of spiny rays to the fins and by its unequal dentition, the "passage of the Acanthodians to the Sauroids."

Although the restored figure of *Cheirolepis* given by Agassiz in the 'Poissons Fossiles du vieux Grès Rouge,' tab. D. fig. 4, is quite erroneous as regards the shape of the maxilla and of the opercular bones, he having evidently supposed that the bones of the head were conformed much as in the recent Salmonidæ, yet as regards his assertion of the presence of branchiostegal rays and of an unequal dentition (facts afterwards questioned by others) he was undoubtedly right.

Our own countryman Hugh Miller, however, was shrewd enough to be impressed with the discrepancy of structure in *Cheirolepis* and the *Cheiracanthi* and *Diplacanthi*, with which it had been classed; and accordingly we find him, in his 'Old Red Sandstone,' mentioning it as the type of a distinct family. Nor did these discrepancies escape the attention of Johannes Müller, as may be seen from a brief passage in his paper "Ueber den Bau und die Grenzen der Ganoiden"\*. By Giebel† it was also disassociated from the Acanthodians and classed amongst his "Heterocerci Monopterygii," a group unfortunately nearly as heterogeneous as Agassiz's "Lepidoides." Nevertheless for years afterwards many eminent palæontologists (such as Pictet‡, Quenstedt§, McCoy||, and Sir Philip Egerton¶) continued to class *Cheirolepis* along with the Acanthodidæ.

Pander, however, in one of his justly celebrated essays on the Devonian fishes\*\* , entered into the structure of *Cheirolepis*, and proposed to constitute for it an independent family, the *Cheirolepini*. Many of its head- and shoulder-bones were

\* Abhandl. der Berl. Akad. 1844, Phys. Kl. p. 151.

† 'Fauna der Vorwelt,' 1848, vol. i. p. 231.

‡ 'Traité de Paléontologie,' 2me éd. t. ii. p. 190.

§ 'Handbuch der Petrefactenkunde' (1852), p. 192. That Quenstedt was nevertheless rather doubtful on this point may be inferred from the following passage, in his description of the Acanthodidæ:—"Nur *Cheirolepis* hat Fulcra an allen Flossen, und auf dem Rücken des Schwanzes; dennoch hält ihn Agassiz auch für einen Acanthodier. Mögen auch alle diese Fische (*ausser Cheirolepis*) den lebenden Haien sich nicht unmittelbar anschliessen, so stehen sie ihnen doch gewiss näher als den folgenden Ganoiden."

|| 'Palæozoic Fossils,' p. 580.

¶ "Remarks on the Nomenclature of the Devonian Fishes," Quart. Journ. Geol. Soc. xvi. p. 123.

\*\* 'Ueber die Saurodipterinen, Dendrodonten, Glyptolepiden, und Cheirolepiden des devonischen Systems,' St. Petersburg, 1860, pp. 69-73.



correctly identified by him ; but he failed to find the branchiostegal rays and the two sizes of teeth described by Agassiz. But it is specially worthy of note that Pander seems to have been struck by the considerable resemblance which certain bones of the head of *Cheirolepis* bore to those shown in Quenstedt's drawing of the head of *Paleoniscus islebiensis* in the 'Handbuch der Petrefactenkunde.'

The question of the systematic position of *Cheirolepis* was next discussed by Prof. Huxley\*. Unfortunately, the material at his disposal at the time he wrote did not afford him the opportunity of making much advance on what had been already done by Pander, though assuredly he was on the right track. He accepted the institution by Pander of a distinct family of *Cheirolepidini*; and as regards the suborder in which this family should be included, he considered that it ought "perhaps to be regarded as the earliest known form of the great suborder of Lepidosteidæ." The single short dorsal fin, the absence of jugular plates, and the non-lobate character of the paired fins were points justly considered by Prof. Huxley as excluding *Cheirolepis* from the Crossopterygidæ.

In 1867, however, Mr. Powrie published a paper † in which he questioned the accuracy of the data on which Prof. Huxley's opinions were founded. *Cheirolepis*, Mr. Powrie affirmed, does possess two large principal jugular plates ; and the structures described by Agassiz as branchiostegal rays, but not seen by Pander or Huxley, "correspond to the lateral jugular plates not uncommon in Ganoid fishes." Although in this paper Mr. Powrie thinks that Prof. Huxley's objections to *Cheirolepis* being a Crossopterygian are so far negatived, he nevertheless does not positively indicate the systematic position in which he thinks it ought to be placed.

In Dr. Lütken's essay on the Classification and Limits of the Ganoids ‡, *Cheirolepis* is placed, somewhat hesitatingly, among the Lepidosteids, Mr. Powrie's jugular plates proving to him rather a stumbling-block. In the English abstract of this elaborate paper, Dr. Lütken states the absence of jugular plates to be one of the characteristics of the group of Lepidosteidæ, "with the sole exception of *Cheirolepis*, the only Devonian fish of the whole series which indicates by its jugular plates a certain relationship to the contemporaneous Polypteridæ"§. Again, in the full German edition published

\* Dec. Geol. Survey, x. (1861) pp. 38-40.

† Geol. Magazine, iv. 1867, pp. 147-152.

‡ Vidensk. Meddelelser nat. For. Kjöbenhavn, 1868.

§ Ann. & Mag. Nat. Hist. 4th ser. vii. p. 331.

in 1873, he says:—"The position of this genus is *somewhat doubtful*; the fuleral armature of all the fins seems to show that its place is here as the oldest member of the Lepidosteid series; but its *gular plates*, which Powrie has pointed out, indicate possibly a certain relationship with—descent from (?)—the Devonian *Polypterini*"\*.

My own observations have been made on a large number of examples of the well-known species *Ch. Cummingia*, Agass., from Cromarty, Lethen Bar, and Tynet Burn. Besides the specimens in the Edinburgh Museum of Science and Art, most of which form part of the Hugh-Miller collection, I have carefully gone over the specimens of *Cheirolepis* in the British Museum and in the Museum of Practical Geology, Jermyn Street; and I am also specially indebted to the Earl of Enniskillen for having, with great kindness, lent me a number of excellent specimens from his collection. The careful examination of these numerous specimens has enabled me, I think, to place the question of the systematic position of *Cheirolepis* on a more satisfactory footing than heretofore, though it is to be regretted that, on many points of detail, our knowledge of the cranial structure of this genus is still rather incomplete.

The key to the whole subject is certainly a knowledge of the structure of *Palæoniscus* and its allies; and had the writers who have previously treated of *Cheirolepis* been better acquainted with the structural details of that remarkable group of extinct fishes, the errors and doubts which have so long hung over its affinities would certainly not have prevailed so long as they have. The general form of the body, with its inequilateral, completely heterocercal tail, the number and shape of the fins, with their strongly fulcerated margins, are common characters, evident to every one without the assistance of the osteology of the head; only the small size, and apparently non-overlapping character, of the scales seemed for long to indicate that its place was with the Acanthodidæ. The scales of *Cheirolepis*, however, are well known to be arranged in very distinct oblique rows or bands, following the same general direction from above downwards and backwards as in rhombiferous Ganoids generally, and meeting in acute angles along the dorsal and ventral mesial lines. On the continuation of the body-axis along the upper lobe of the caudal fin, however, the direction of these bands is suddenly changed to

\* Dunker und Zittel's 'Palæontographica,' xxii. erste Lieferung, 1873, p. 25, note.

one from above downwards and forwards—exactly the opposite; and this change takes place nearly opposite the middle of the origin of the lower lobe of the caudal. Though this fact is not alluded to by Pander in his description, it is most distinctly represented in tab. ix. fig. 1 of his illustrations. On examining the tail of *Palaeoniscus*, *Amblypterus*, or any allied genera, precisely the same phenomenon is invariably seen to occur—viz. the sudden alteration of the direction of the oblique bands of scales on the upper caudal lobe to one at right angles to that of the bands covering the rest of the body\*. In *Cheirolepis*, too, as in these genera, the scales clothing the sides of this caudal body-prolongation become acutely lozenge-shaped as we trace them on towards the tip of the tail. I have not observed in front of the azygos fins the peculiar large scales which in most Palaeoniscidæ precede the dorsal, anal, and lower lobe of the caudal, ultimately passing into the fulcra of these fins; but on the upper margin of the tail the arrangement of large V-scales is characteristic, and entirely in accordance with that in the heterocercal Lepidosteids and also in *Acipenser* and *Polyodon*. These have been so well illustrated in one of Prof. M'Coy's figures† that there is no necessity for describing them further in this place; enough has been said to show how strikingly *Cheirolepis* deviates from the Acanthodidæ in all points connected with the scales save their minute size, and how close, on the other hand, is the approach which it makes to *Palaeoniscus* in the general arrangement of these appendages. And even as regards the smallness of the scales, it is to some extent kept in countenance by the undoubtedly Palaeoniscoid *Myriolepis Clarkei*, Egerton, so far as we can judge from the beautiful figure given by its eminent describer‡.

The fins of *Cheirolepis* are composed of very numerous rays frequently dichotomizing, and divided transversely by very numerous articulations; the rays are very closely set, and the demi-rays of each side imbricate over each other from before backwards, like those of the anal fin of *Polypterus*, while conspicuous fulcral scales serrate their anterior margins. The arrangement here is in all essential respects identical with

\* It is an interesting fact that the patch of rhombic scales on the side of the vertebral prolongation in the tail of *Acipenser* and of *Polyodon* (in the latter genus the only scales, along with the "fulcra" above them, which occur on the body at all) correspond exactly in arrangement with this peculiarly arranged caudal patch of scales in the Palaeoniscidæ. A similar arrangement is also traceable in the imperfectly heterocercal tail of *Lepidosteus*.

† 'Palaeozoic Fossils,' pl. 2 D. fig. 3.

‡ Quart. Journ. Geol. Soc. xx. 1863, pl. i. fig. 1.

that in the Palæoniscidæ; but the minute articles of the rays are finer and more scale-like, and, as M'Coy has aptly expressed it, present "a deceptive resemblance to the scales of the body." This view of the structure of the fins of *Cheirolepis*, however, is denied by Pander, who affirms that the apparent joints of the fin-rays are in reality nothing but *scales* which covered internal rays apparently of a flexible nature; and such internal non-jointed rays he has actually represented in tab. ix. fig. 2 of his work. Here I feel myself compelled to dissent from the opinion of so high an authority as Pander, and to agree with Agassiz and M'Coy—as, in spite of the most careful examination of a large number of specimens from various localities, I have never seen any thing like the unarticulated rays represented in his figure, and, moreover, a transverse section of a small portion of the lower lobe of the caudal, from a Cromarty nodule (Pl. XVII. fig. 6), effectually (to my eyes at least) demonstrates the contrary. Here the whole thickness of the fin is seen to consist of the right and left sets of imbricating demi-rays, no other hard parts being visible. And although it is of course not impossible that such internal soft rays may have been present, yet the structure as here shown exhibits the most complete analogy, or rather identity, with that of the anal fin in *Polypterus* and *Calamoichthys*, in which certainly no other rays exist save those whose ganoid, closely jointed, and imbricating surfaces are seen on the outside\*.

The *shoulder-girdle* must next claim our special attention, seeing that one of its elements seems to have escaped the observation of previous writers, save Powrie, and to have been by him completely misinterpreted. Of this the first element, by which the arch was attached to the skull, is the *first supraclavicular*, or "suprascapular" (Pl. XVII. fig. 3, 1st s.cl), a small rounded-triangular plate placed immediately behind the posterior margin of the cranial shield, and distinctly seen only in very few specimens. It is correctly indicated by Pander, in tab. ix. fig. 6 of his work, by the number 46. Articulated with this is the *second supraclavicular* (2nd s.cl), or "scapular," a more elongated plate, broadish above, but getting suddenly narrower about the middle, and whose long axis points obliquely downwards and backwards to articulate

\* Agassiz was nevertheless inclined to believe that in *some* species of *Palæoniscus* (e. g. *P. Blainvillei* and *P. Voltzii*) the fin-rays were really covered with scales (Poiss. Foss. t. ii. pt. 1, p. 43). I do not, however, find this idea corroborated by the specimens of *Palæoniscus Blainvillei* in the British Museum, which I have carefully examined; *P. Voltzii* I have not seen.

with the clavicle. This bone is seen in Pander's tab. viii. fig. 2 and tab. ix. figs. 3 & 5, but also marked 46, the same as the preceding\*. Articulated with its lower extremity is the *clavicle* (figs. 2 & 3, *cl*), a bone so strong that it is conspicuous in every nodule specimen, and seems to have been able to resist compression in very many cases where every thing else is crushed quite flat. This clavicle is composed of two parts, set at a considerable angle to each other. Of these, the upper or vertical part, set on the side of the shoulder and forming part of the hinder margin of the branchial opening, is of a somewhat lanceolate shape, with the posterior margin more convex than the anterior, and with the apex directed obliquely upwards and backwards to the lower end of the bone last described. A nearly vertical line divides the outer surface of this part into two, the anterior of which looks rather forwards into the branchial cavity. The lower part of the bone, much smaller and somewhat quadrate in form, projects inwards towards the ventral middle line; between the two parts, behind, is a notch from which the pectoral fin issued. This bone, the *clavicle*, is numbered 48 in Pander's figures; but in tab. ix. figs. 3 & 5 the number is placed on the element next to be described, which is not represented as distinct; and in tab. viii. fig. 2 it is also placed on a bone which is undoubtedly the operculum. The last element of the shoulder-girdle articulated to the front of the lower end of the clavicle is the *interclavicular* plate (figs. 2 & 3, *i.cl*), a bone which among recent Ganoids is not found in *Lepidosteus* or *Amia*, though it occurs both in *Polypterus* and *Acipenser* and also in *Polyodon*, and in them lies, as it does here, on the so-called "isthmus." It consists of a pointed plate of bone, sharply bent on itself along a line continued forwards from the line of junction of the two portions of the clavicle, when the two bones are in apposition. It thus comes also to present two portions or aspects—the one looking upwards and outwards, forming part of the gill-slit below the branchiostegal rays, and the other covering the ventral surface of the isthmus. Seen from below, the ventral portion of the interclavicular plate is of a somewhat elongated triangular form, the apex directed forwards towards the symphysis of the jaw, the short posterior side articulating with the lower end of the clavicle, and in close apposition to its fellow of the opposite side, by about two thirds of its long internal margin, in specimens

\* There is probably an error in the lettering here, as the number 47, which Pander assigns to the "scapula," does not occur on the plate at all.

where this relation has been left undisturbed\*. These interclavicular plates are certainly the structures which have been figured and described by Powrie as "principal jugulars"—a mistake into which he never could have fallen had he observed their relation to the clavicles, or had he taken into consideration the structure of the shoulder-girdle in the recent *Polypterus* or in the extinct Palæoniscidæ. And in the presence and configuration of this, as of all the other elements of the shoulder-girdle, the closest resemblance is seen between *Cheirolepis* and the genera of fossil fishes allied to *Palæoniscus*, for corroboration of which the reader need only refer to my description of the same parts in *Cycloptychius carbonarius*†, and in *Pygopterus* (*Nematoptychius*) *Greenockii* and *Amblypterus punctatus*‡.

Passing now to the bones of the *face*, we find the most singular conformity to the general type of structure in *Palæoniscus* and its allies—a fact which, as already mentioned, did not altogether escape the notice of Pander. In the first place, the gape is very wide, the direction of the axis of the suspensorium and of the opercular apparatus passing obliquely downwards and backwards, so as to carry the articulation of the lower jaw far enough behind. The *superior maxillary* bone (Pl. XVII. figs. 1 & 7, *mæ*) has been very correctly figured by Pander, and is formed on the same type as in all the Palæoniscidæ. It consists of a plate of bone, broad behind the eye, and there covering a large part of the cheek; but immediately behind the orbital ring the superior margin becomes suddenly cut out, so that the anterior extremity passes forwards below the orbit, tapering to a point towards the premaxillary region. The inferior or dental margin is not quite straight, but shows a slight sigmoid curve; the posterior inferior angle is rounded, while the short posterior margin, sloping obliquely upwards and forwards, joins the straight part of the superior margin at a very obtuse angle. Closely articulated to the maxilla is a rather narrow plate (fig. 7, *x*), consisting of two parts diverging at an obtuse angle. The upper and anterior of these lies along the superior margin of the maxilla behind the orbit, the lower and posterior one passing down for some distance along the oblique posterior margin of the same bone, between it and the suboperculum, the centre of ossification

\* Though in the specimen represented in Plate XVII. fig. 2 the interclavicles have been forced apart, their juxtaposition is beautifully shown in No. 41725 of the British-Museum collection, and many others which I have seen. They are also in contact with each other in Mr. Powrie's figure; but there both are also disjoined from their respective clavicles.

† Geol. Magazine, 2nd series, vol. i. June 1874.

‡ Trans. Royal Soc. Edinburgh, 1867, xxiv. pp. 707, 708. In this paper I called the interclavicular *precoracoid*.

being placed near the angle of divergence. This plate is marked *x* in Pander's figures, and seems to correspond to a similar though somewhat smaller one seen in most Palæoniscidæ, and which in Quenstedt's previously quoted figure of the head of *Palæoniscus islebiensis* is marked as "*præoperculum*." How far it represents a præoperculum is doubtful, though it certainly does occupy a very analogous position to that of the great præopercular cheek-plate in *Polypterus*. Above the margin of the anterior limb of this plate is frequently seen another portion of bone (fig. 7, *y*), the interpretation of which does not seem very clear, but which may very possibly be a portion of the *hyomandibular* exposed from under the previously described plate. The *lower jaw*, long and powerful in accordance with the great backward extent of the gape, was undoubtedly the strongest of all the bony parts of the head, as its contour, like that of the clavicle, is easily recognizable in most specimens. Its dentary portion (figs. 1 & 7, *d*) has been well figured by Pander, and is peculiar in presenting on its lower margin a wide shallow notch rather in front of its middle, and immediately above which the centre of ossification was placed. Besides the dentary portion, distinct *articular* and *angular* elements (fig. 7, *ag*) are recognizable; but I have never succeeded in detecting any inner or *splénial* plate, though I have often seen it in many Carboniferous Palæoniscidæ. The *operculum* (fig. 7, *op*) seems to have been a very delicate plate, as it is only in very few specimens that any trace of it is seen. However, it is unmistakably shown in one of Lord Enniskillen's specimens, and in Nos. 255 and 435 of the Hugh-Miller collection; and though Pander states that he was unable to detect it, yet the plate marked 48 in his tab. viii. fig. 2, as an element of the shoulder-girdle, clearly corresponds with it both in form and position. It is a narrow, elongated, thin plate, with acute anterior-superior and posterior-inferior angles, and placed obliquely on the side of the head, between the suspensorium and the shoulder-girdle. The *suboperculum* (*s.op*) is also rarely shown, and I have come across no specimen in which the whole of its contour is distinctly exhibited; to judge, however, from its remains, it seems to have been a somewhat square-shaped plate, placed immediately below the inferior margin of the operculum. This is undoubtedly the plate marked 3 in Mr. Powrie's figures, and which he supposes "may have represented the operculum."

The *branchiostegal rays*, described and figured by Agassiz, were not observed by Pander nor by Prof. Huxley, though he accepts and quotes Agassiz's statement regarding them.

They were figured and described by Powrie, who considered them, however, to be "lateral jugular plates"—an opinion which, I think, he would scarcely have advocated save as a corollary to his view that the interclavicular plates were "principal" jugulars. The branchiostegal rays are beautifully displayed in a specimen in Lord Enniskillen's collection (Pl. XVII. fig. 1), in no. 41725 of the British-Museum collection, and also in nos. 134 and 360 of the Hugh-Miller collection. Twelve of them are counted below each mandibular ramus in Lord Enniskillen's specimen, though there may have been more; and of these the anterior one on each side is large, broad, and somewhat triangular in shape, the rest being long and narrow. In a specimen of *Amblypterus punctatus*, Agass., from Wardie, now before me, and of which I have given a diagrammatic sketch in a paper already quoted, exactly the same arrangement of branchiostegal rays or plates is seen, with this exception—that between the two large anterior ones a lozenge-shaped azygos one is placed immediately behind the symphysis of the jaw; but of this I have never seen any very clear evidence in *Cheirolepis*.

There is very distinct evidence in *Cheirolepis* of a circle of plates surrounding the orbit, as in *Puleoniscus*, but concerning which it is impossible to furnish any more special details; Pander indeed mentions the arrangement as being formed by one large perforated plate.

Specimen no. 41310 of the British-Museum collection shows that the top of the head was traversed longitudinally by a pair of slime-canals following a flexuous course, similar to those in *Puleoniscus*; but I have never seen any specimen showing the individual bones of the cranial roof so well as to enable one to make a satisfactory figure of them. What I have been able to observe confirms Pander's statement as to the two *parietals*, followed by a pair of more elongated *frontals*. External to these there seem to lie on each side two plates, the posterior of which would seem to represent the *squamous* plate seen outside the parietal in *Lepidosteus* and *Amia*, while the anterior may correspond to the *postfrontal* scale-bone seen in the last-mentioned fish. These have nothing to do with the three bones mentioned by Pander as occupying a similar position, and marked 46, *x* and *y*, in his figures, which, as he himself surmises, undoubtedly belong to the shoulder-girdle and face. The snout seems to have been rounded and blunt; but no specimen which I have seen has revealed any thing describable regarding the bones of the nasal region, including the *præmaxilla*. The same must unfortunately be also said of the side walls and base of the skull, of the



palato-quadrate apparatus, and of the hyoid and branchial arches.

Regarding the *dentition* of *Cheirolepis* there has also prevailed some little obscurity. Agassiz describes the teeth as being indeed of two sizes, but all arranged in one line, and in that respect differing from the unequal dentition of his "Sauroids" and "Cœlacanth," in which the smaller teeth form a continuous external range. Pander and Huxley describe the jaws as being set with small conical teeth, but they were unable to find any of the larger ones referred to by Agassiz; while Powrie, on the other hand, returns to the statement of Agassiz regarding the larger and smaller teeth being in one row. According to the specimens which have come under my own observation, the jaws of *Cheirolepis* were set along the inner aspect of their dental margins with one row of tolerably equal and rather closely set, sharp, and acutely conical teeth, each having a marked inward curve, and, when broken, displaying a large simple internal pulp-cavity. These are undoubtedly the teeth referred to and figured by Pander, who, however, seemed to expect that, according to Agassiz's description, *larger* ones would be found among them. Now, other teeth of a different size do exist—not larger, however, but *smaller*; and these form a row *external* to those first described. The outer row of smaller teeth, the discovery of which at once breaks down Agassiz's demarcation between the dentition of *Cheirolepis* and that of his so-called "Sauroids" and "Cœlacanth," is not often seen, from the fact that the edge of the jaw on which they are placed is almost invariably found split off and adherent to the matrix of the "counterpart," and thus the little teeth in question are hidden. But by careful working out with the point of a needle, I have been able to display some of them in two cases where a portion of the edge of the jaw remained, as shown in Plate XVII. figs. 4 and 5. They are indeed very minute, being only about one third or one fourth the length of the larger ones, which themselves only measure  $\frac{1}{12}$  inch in specimens of the ordinary size. The dentition of *Cheirolepis* is thus reduced to a type very frequent in Ganoid fishes, and which notably occurs in many, if not in most, of the genera comprised in the family of Palæoniscidæ.

The facts adduced in the preceding pages seem most satisfactorily to prove not only that *Cheirolepis*, as Prof. Huxley has already indicated, must take its place among those Ganoids which he has brought together under his suborder of Lepidosteidæ, but also that among those Lepidosteids it must

be classed along with *Palæoniscus*, *Pygopterus*, *Oxygnathus*, *Cycloptychius*, and other genera which constitute the long-extinct family of Palæoniscidæ. So close indeed is the correspondence between the general organization of *Cheirolepis* and of *Palæoniscus*, that at most only the distinction of a separate "subfamily" can be accorded to it, in virtue of the peculiarity of its scales. Though the precursor of a numerous tribe of most interesting fishes in the Carboniferous and Permian eras, and which finally disappear with the Lias, *Cheirolepis* stands alone in the Devonian fauna, so far as that has been as yet revealed to us\*; and no peculiarity of its structure throws the smallest additional light on the evolution of the group to which it belongs; for the absolute divergence in all other points of structure utterly excludes the idea that its minute scales betray any special affinity to the Acanthodians, while the correct determination of the plates, which have been mistaken for jugulars, equally forbids any association of it with the "contemporaneous Polypteridæ."

#### EXPLANATION OF PLATE XVII.

- Fig. 1.* Represents the mandibles and branchiostegal rays of both sides of *Cheirolepis Cumingia*, also the right maxilla and part of the circumocular ring. From a specimen from Lethen Bar, in the collection of the Earl of Enniskillen.
- Fig. 2.* Both interclavicular bones, with the left clavicle and the lower extremity of the right clavicle. From a specimen from Cromarty in the Hugh-Miller collection, Edinburgh Museum of Science and Art.
- Fig. 3.* Outline of the shoulder-girdle and its component bones, restored.
- Fig. 4.* A small portion of the edge of the superior maxillary bone, magnified two diameters. The outer row of small teeth is exhibited, also one of the larger ones and the broken stump of another. Hugh-Miller collection.
- Fig. 5.* Portion of the dentary bone of the mandible of another specimen. Along one half of the bone the outermost edge has been broken away, thus carrying off the small ones and exhibiting the inner row of larger teeth; along the other half this edge remains, and shows some of the small teeth, while the continuation of the row of large ones is concealed by the matrix. The working-out of the small teeth has not been so successful here as in the preceding specimen.
- Fig. 6.* Vertical transverse section of a small portion of the lower lobe of the caudal fin, magnified two diameters.
- Fig. 7.* Restored outlines of some of the bones of the side of the head. The radiating lines on some of the bones are those which, on

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\* With the apparent exception of four species of *Acrolepis*, described by Eichwald from the "Old Red" of Russia ('*Lethæa Rossica*, vol. i. pp. 1578-1581).

their under surfaces, are seen passing from their centres of ossification.

In all these figures the same letters apply to the same bones. *mx*, maxilla; *mn*, mandible; *d*, dentary; *ag*, angular; *su.o*, sub-orbital; *x*, cheek-plate above the maxilla; *y*, portion of hyo-mandibular (?); *op*, operculum; *s.op*, suboperculum; *br*, branchiostegal plates or rays; *1st s.cl*, first supraclavicular; *2nd s.cl*, second supraclavicular; *cl*, clavicle; *i.cl*, interclavicular.

### XXXI.—On a new Species of *Liphistius* (*Schiödte*).

By the Rev. O. P. CAMBRIDGE, M.A., C.M.Z.S.

THE British-Museum collection contains a fine specimen of this remarkable genus from Penang, the same locality whence the typical species *L. desultor*, Schiödte\*, was obtained. In almost every essential particular the British-Museum example agrees with *L. desultor*, except in being larger and possessing four mammillary organs of considerable size beneath the abdomen, immediately behind the second pair of spiracular apertures. Prof. Schiödte makes no mention of such organs, describing *L. desultor* as "mammillis textoriis nullis." Whether the organs in the British-Museum specimen are, or not, true spinning-organs seems doubtful, inasmuch as an examination lately made under a microscope by Mr. A. G. Butler has failed to reveal any spinning-tubes.

It is not without some reluctance that I have determined to characterize the example in the British Museum as a new species. It appeared to me possible that the mammillary organs might have been overlooked or destroyed in the specimen from which Prof. Schiödte described *Liphistius desultor*; I am, however, compelled to shut out the idea of this possibility, after receiving a communication on the subject (through Dr. Thorell) from Prof. Schiödte. From this communication it appears that when the specimen came into Prof. Schiödte's hands it was in a dry state, having been opened along the middle line of the underside of the abdomen and, after extraction of the contents, stuffed with cotton; it was then placed in spirit of wine. Prof. Schiödte thinks it almost impossible for the collector (Dr. Teylingen, himself a good zoologist) to have overlooked or destroyed the mammillæ, if they had been present; the incision through the abdomen had the appearance of being exceedingly clean and even; and the surface showed no loss whatever of substance. Under these

\* *Vide* description and figures of *Liphistius desultor*, in Kröyer's 'Naturhist. Tidsskr. N. R.' Bd. ii. 1849, pp. 617-624, tab. 4.

circumstances, the conclusion seems inevitable that the example possessing the four mammillary organs (and these placed in so abnormal a position), whatever may be their true nature and office, must be of a different species from that described by Prof. Schiödte.

I therefore propose to call the British-Museum example *Liphistius mammillanus*, and briefly to characterize it as follows:—

*Liphistius mammillanus*, n. sp.

Adult female, length 20 lines = 42 millims.

*Abdomen* similar in colour to that of *L. desultor* (Schiödte), and its upperside similarly covered by a longitudinal series of transverse articulated corneous plates. The spiracular plates are four in number, grouped closely together beneath the fore extremity of the abdomen (fig. 1, *b b b b*); and immediately behind them are four mammillary organs, placed two and two, as represented (fig. 1, *a a a a*); the two foremost are much larger than the two hinder ones, of a curved subconical or rather tapering form, composed of several (about twelve) articulations or rings, of which the basal one is much the largest; the two hinder organs are somewhat similar in form, though much smaller, and the basal annulation is not nearly so broad

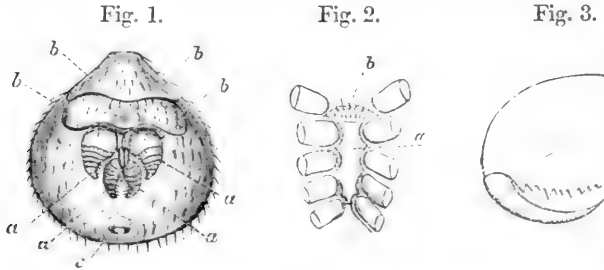


Fig. 1. Underside of abdomen: *a a a a*, mammillary organs; *b b b b*, spiracular plates; *c*, anal tubercle and orifice. Fig. 2. *a*, sternum; *b*, labium. Fig. 3. One of the falces.

in proportion; the several annulations are fringed with short hairs on their posterior edges. These organs are capable of vertical, but not horizontal movement. The anal aperture seems to be in rather a different position from that represented in Prof. Schiödte's plate (fig. 7), where it occupies the posterior extremity of the abdomen, while in the present spider it is placed considerably beneath it (fig. 1, *c*).

The *sternum* (fig. 2, *a*) differs a little in form from that of *Liphistius desultor*; while the *eyes* appear to be similar both

in their relative size and position. The *labium*, however, though similar in form, is distinctly broader than the fore extremity of the sternum (fig. 2, *b*); while in *L. desultor* it is represented in figure 5 of Schiödte's plate as narrower.

A single example of the adult female in the British Museum.  
*Hab.* Penang.

Naturalists and collectors in Penang should endeavour to find other examples of this genus, of which all our knowledge at present is based upon the two specimens mentioned above. Besides the interest attaching to the presence or absence of spinners, they are the only spiders, as yet discovered, whose abdomen is protected by articulated corneous transverse plates, similar to those found in the orders Scorpionidea and Thelyphonidea.

### XXXII.—On the Geographical Distribution of Fishes.

By THEODORE GILL, M.D., Ph.D.\*

ABOUT 9000 species of living teleosteous fishes are now known, variously distributed and found in greater or less numbers in almost all the waters of the globe, fresh and salt; the greatest numbers of species, however, are found in the tropical waters, and especially in the seas of the Indo-Moluccan archipelago. The distribution of the types, especially of the marine species, to a considerable degree coincides with thermometrical conditions. In the polar and northern temperate regions, for example, are found representatives of the families of Gadoids or codfishes, Lycodoids, Stichæoids, Liparidoids, Cottoids or sculpins, and others less known. In the tropical regions many forms are distributed throughout the entire zone (and therefore designated as tropicopolitan), this being especially the case with many genera of Labroids, Scaroids or parrot-fishes, Pomacentroids, Gerreoids, Serranoids or groupers, Sparoids, Carangoids, and others—numerous species of these families being found in torrid waters, while very few extend far northward or southward. In the antarctic regions, again, we have another combination of forms: typical codfishes and the other types characteristic of high northern latitudes are wanting, but are severally replaced by peculiar groups, which seem to fill an analogous place in the economy of nature, having a superficial resemblance in general aspect, although they are not at all (comparatively speaking) related in structure.

\* Reprinted, with additions by the Author, from advance sheets of 'Johnson's New Universal Cyclopædia.'

The Gadoids, for example, are replaced by Notothenioids, the Lycopoids by peculiar genera, the Cottoids by Harpagiferoids, &c. In the contrast between these antarctic and the arctic forms we have evidence of the absence of any paramount causal relation between temperature and structure; and, in addition to the "tropicopolitan" types, each great tropical region has a number of characteristic and peculiar types.

But the distribution of the inhabitants of the great open seas and of those of the inland waters are determined by different conditions, as might *à priori* be supposed. While, for example, the inhabitants of the opposite sides of converging continents are to a great extent similar, the freshwater species of those continents are mostly quite dissimilar, and become more and more so as we progress southward.

There are numerous families of fishes which are represented in the fresh waters—some exclusively so, others with marine species. The geographical limitations and relations in space of these families may be exhibited under combinations in several categories\*, viz. :—

1. Peculiar to North America—Percidæ (*Etheostominae*), Centrarchidæ, Aphredoderidæ, Amblyopsidæ, Percopsidæ, Hyodontidæ, Amiidæ, and Lepidosteidæ.

2. Peculiar to Tropical Asia—Platypteridæ, Helostomidæ, Osphromenidæ, Nandidæ, Luciocephalidæ, Ophiocephalidæ, Notopteridæ, Salangidæ, Homalopteridæ, and Sisoridæ.

3. Peculiar to Africa—Kneriidæ, Mormyridæ, Gymnarchidæ, and Polypteridæ.

4. Peculiar to tropical America—Centropomidæ, Polycentridæ, Sternopygidæ, Electrophoridæ, Hypophthalmidæ, Trichomycteridæ, Callichthyidæ, Argiidæ, Loricariidæ, and Aspredinidæ.

5. Peculiar to Australia—Gadopsidæ, Ceratodontidæ.

6. Peculiar and common to the cistropical hemisphere (that is, Northern America, Europe, and Northern Asia)—Gadidæ (*Lotinae*), Cottidæ (*Uranidæ*), Percidæ (*Percinae*), Gasterosteidæ (*Gasterosteinae*), Esocidæ, Umbridæ, Catastomidæ (America and Eastern Asia), Salmonidæ, Acipenseridæ, and Polyodontidæ (America and Eastern Asia).

7. Peculiar and common to Europe and Asia—Cobitidæ.

\* As might naturally be supposed, the forms assigned to the categories enumerated are not always rigidly limited to the specific regions when contiguous regions are contiguous: thus the Cichlidæ send representatives into the regions of Asia near Egypt, and the Lepidosteidæ have a representative as far southward as Panama. In the latter case, indeed, the question might even arise whether the Lepidosteidæ might not rather be immigrants into North America than the reverse; but a recourse to palæontology solves the question.

8. Peculiar and common to South America and Australia—Percophididæ, Haplochitonidæ, Galaxiidæ, and Osteoglossidæ.

9. Peculiar and common to tropical and subtropical America and Africa—Cichlidæ, Characinidæ, and Lepidosirenidæ.

In addition to these, the family Cyprinidæ is represented in the entire cistropical or "arctogean" hemisphere as well as in tropical Africa and Asia; and there are several monotypic families limited to very small regions, such as the Comephoridæ, the single species of which is only known from Lake Baikal. There are, further, a number of families (in addition to several already mentioned) which are chiefly represented by marine species, but which have also a greater or less number of representatives in fresh water in different regions of the earth; such are the Brotulidæ, Blenniidæ, Gobiidæ, Sciaenidæ, Atherinidæ, Mugilidæ, Cyprinodontidæ, Microstomidæ, Clupeidæ, Dorosomidæ, &c.

Others, again, were represented in former epochs in parts of the world where they are not now found; and especially to be noted among these are two families at present characteristic in their distribution: the first of these is the Cobitidæ, which in the early Tertiary were inhabitants of Western America, and which thus increased the similarity of the fauna of our (cistropical) continent to that of Northern Asia; the second is the Ceratodontidæ, a family whose representatives have long been known from fossil teeth found in Palæozoic and Mesozoic deposits (and which were referred by Prof. Agassiz to the sharks), and had been supposed to have expired towards the end of the Triassic epoch; yet recently (since 1870) two species, closely allied to those found in the Triassic beds of Europe, have been discovered *living* in Australia; and thus another ancient type has been preserved in that continent to illustrate the past life of our own hemisphere.

If we now seek to apply the knowledge thus gained to the appreciation of the origin of the different fish-faunas of the globe, we are forced to the following conclusions.

Inasmuch as the cistropical hemisphere shares in common the same families, and to a considerable extent the same genera (and even some species), it is presumable that the different regions of that hemisphere have derived their inhabitants from a common primitive source, although North America has quite a large proportion of forms peculiar to it. The relation of these peculiar forms, however, are in all cases rather with some found in the northern hemisphere (freshwater or marine) than with any found elsewhere; but, at the same time, towards the south-western limits of the United States occur representatives of families which are characteristic of tropical

America. Further, it is to be remarked that several of those forms whose living representatives are most characteristic and peculiar to North America, *e. g.* Amiidae and Lepidosteidae, were in previous geological epochs represented by species in Europe; while the Cobitidae, now unrepresented by living American species, had, as already remarked, examples in more ancient times in that continent.

Tropical Asia nourishes a great number of peculiar forms; but the relations of those are intimate either with eistropical ones or with marine types.

Africa has Cyprinoids and Anabantids in common with tropical Asia, and Cyprinoids in common with the eistropical hemisphere; but it also supports several very peculiar families for whose relations we have to seek in other continents.

In tropical America are to be found the nearest relations of some of these African types, and several almost or quite limited to those two continents. On the other hand, in South America are found several families having no analogues in the parts of the world yet mentioned, but for which we have to turn our eyes to Australia; and there we have representatives of not only the same families, but even, it has been contended, one of the same species. Under these circumstances we are almost compelled to believe that the fish-fauna of South America was derived, at a distant epoch, to some extent from a common source with that of Africa and that of Australasia. We have, however, at first sight, contrary indications; but they are not irreconcilable: the most conspicuous and, as it were, obtrusive types of South-American fishes are analogues of African forms, members of the families Cichlidae and Characinidae; but the species belong to widely different genera. On the other hand, although the types common to South America and Australia are not conspicuous in numbers or economical importance, they are much more nearly related to corresponding Australian species than the former, and, in common with other facts, tend to verify Huxley's views respecting an "Austro-Columbian" fauna.

In fine, dividing the earth into regions distinguished by general ichthyological peculiarities, several primary combinations may be recognized, *viz.*:—1, an *Arctogean*, embracing Europe, Northern Asia, and Northern America; 2, an *Asiatic*, embracing the tropical portions of the continent; 3, an *African*, limited to the region south and east of the Desert; 4, an *American* embracing the America *par excellence* dedicated to Amerigo Vespucci, including the tropical and transtropical portions; and, 5, an *Australasian*. Further, of these (a) the



first two have intimate relations to each other, and (b) the last three others among themselves; and some weighty arguments may be adduced to support a division of the faunas of the globe into two primary regions coinciding with the two combinations alluded to—(a) a CÆNOGÆA and (b) an EOGÆA, which might represent areas of derivation or gain from more or less distant geological epochs.

In connexion with the geographical distribution of fishes there are a couple of empirical facts which are also specially noteworthy. In the order of Teleocephali the Acanthopterygian types are vastly preponderant in the tropical and subtropical waters, while the jugular Malacopterygian types (*e. g.* Lycodidæ, Gadidæ, &c.) form a large proportion thereof in the polar regions. Further, and it is in the same direction, in Acanthopterygian types the vertebræ are actually or approximately 24, divided between 10 abdominal and 14 caudal, in the great majority of the tropical saltwater species; while in the cold-water forms (arctic and antarctic) the number is considerably increased. There are many exceptions to this generalization so far as the tropical forms are concerned; but the tendency in the direction in question is so decided, that while in the warm-water forms of the typical *Scorpeninæ* (*Sebastosomus*, *Scorpena*, &c.) the vertebræ are 24 (A. 10 + C. 14), in the representatives which are peculiar to the high north (*Sebastes norvegicus* and *S. viviparus*) the vertebræ are increased in number to 31 (A. 12 + C. 19). There is, however, no apparent physiological or morphological correlation between these and other facts, and we have in them perhaps nothing more than interesting cases of irrelative coincidence.

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XXXIII.—On an undescribed Organ in *Limulus*, supposed to be Renal in its Nature. By A. S. PACKARD, Jun.\*

In dissecting the king crab one's attention is directed to a large and apparently important gland, conspicuous from its bright red colour contrasting with the dark masses of the liver and the yellowish ovary or greenish testes, and presenting the same appearance in either sex. The glands are bilaterally symmetrical, one situated on each side of the stomach and beginning of the intestine, and each entirely

\* From an advance sheet of the 'American Naturalist,' communicated by the Author, having been read at the Philadelphia Meeting of the National Academy of Sciences, held in November 1874.

separate from its fellow. One of these glands consists of a stolon-like mass, running along close to the great collective vein, and attached to it by irregular bands of connective tissue, which also holds the gland in place. From this horizontal mass four vertical branches arise, and lie between and next to the partitions at the base of the legs, dividing the sides of the body into compartments. The posterior of these four vertical lobes accompanies the middle hepatic vein from its origin from the great collective vein, and is sent off opposite the insertion of the fifth pair of feet. Halfway between the origin of the vein and the articulation of the foot to the body it turns at a right angle, the ends of the two other lobes passing a little beyond it, and ends in a blind sac, less vertical than the others, slightly ascending at the end, which lies just above the insertion of the second pair of feet. The two middle lobes are directed to the collective vein. Each lobe is flattened out somewhat, and lies close to the posterior wall of the compartment in which it is situated, as if wedged in between the wall and the muscles between it and the anterior portion of the compartment. Each lobe also accompanies the bases of the first four tegumentary nerves. I could not make out any general opening\* into the cavity of the body by injection of the gland, or any connexion with the hepatic or great collective vein, all attempts to inject the gland from the veins failing. The four lobes certainly end in blind sacs. The lobes are irregular in form, appearing as if twisted and knotted, and with sheets and bands of connective tissue forming the sheaths of the muscles among which the gland lies. Each lobe, when cut across, is oval, with a yellowish interior and a small central cavity, forming evidently an excretory duct. The gland externally is of a bright brick-red. The glandular mass is quite dense, though yielding. It is singular that this conspicuous gland, though it must have engaged their attention, has not been noticed by Van der Hoeven, Owen, or A. Milne-Edwards in their accounts of dissections of this animal.

When examined under a Hartnack's no. 9 immersion-lens and Zentmayer's B eyepiece, the reddish external cortical portion consists of closely aggregated irregularly rounded nucleated cells of quite unequal size; and scattered about in the interstices between the cells are dark reddish masses which give colour to the gland. They are very irregular in size and

\* Leydig ('*Naturgeschichte der Daphniden*') states that several anatomists, after laborious attempts, have failed to find the opening to the green gland in any crustacean.

form, and, twenty hours after the portion of the parenchyma submitted to microscopic examination, vibrated to and fro. I am reminded in the vibrating movements of these bodies of Siebold's description ('Anatomy of the Invertebrates') of similar bodies in the renal organs of the Lamellibranchs, *i. e.* the gland of Bojanus. He says in a footnote, p. 214 (Burnett's translation):—"If the walls of these organs are prepared in any way for microscopic examination, a part of their parenchyma separates into a vesiculo-granular mass, the particles of which have a very lively dancing motion. The motions are due to portions of ciliated epithelium adhering to the cells and granules."

In other portions of the outer reddish part of the gland, where the pigment(?) masses are wanting, the mass is made up of fine granular cells, not nucleated. Other cells have a large nucleus filled with granules and containing nucleoli.

In the yellowish or, as we may for convenience call it, the medullary portion are scattered about very sparingly what are probably the round secreting cells. The nucleus is very large and amber-coloured, with a clear nucleolus; others have no nucleolus; and the small ones are colourless.

I am at a loss to think what this gland, with its active secreting cells filled with a yellowish fluid, can be, unless it is renal in its nature. This view is borne out by the fact of its relation with the hepatic and great collective vein. If future examination shows some outlet into the venous circulation, then its renal nature would seem most probable. No other organ that can be renal in its nature exists in *Limulus*. In its general position and relations it is probably homologous with the green gland of the Decapod Crustacea and its homologue in the lower orders of Crustacea, which is supposed also to be renal in its nature. It may also possibly represent the organ of Bojanus in the Mollusca, which is said to be renal in its function. It perhaps represents the glandular portion of the segmental organs in worms. That so large and important a gland is an embryonic gland, in adult life aborted and disused, is not probable; nor is there any good reason for regarding it as analogous to the suprarenal capsule of the vertebrates, analogues of which are said by Leydig to exist in *Paludina* and *Pontobdella*.

Reasoning from their histological structure and by exclusion, it seems not improbable that these glands are renal in their nature, and homologous with the green glands of the normal Crustacea. They seem also homologous with the organs described by M. A. Giard in the Rhizocephala, and

said by him to be "situated on each side of the middle part of the animal, and generally coloured yellow or red (primitive kidneys?)" (Ann. & Mag. Nat. Hist. Nov. 1874, p. 383).

I may add that all these observations were made on living *Limulus polyphemus*, in the laboratory of the Anderson School of Natural History, at Penikese Island, Mass.

XXXIV.—*On some Fossil Fishes from the Neighbourhood of Edinburgh.* By R. H. TRAQUAIR, M.D., F.G.S., Keeper of the Natural-History Collections in the Edinburgh Museum of Science and Art\*.

[Plate XVI.]

I. *Nematoptychius Greenockii*, Agass., sp.

EIGHT years ago I published a paper † giving a detailed description of a fish from the Wardie Shales, which I considered, and still do so, to be the *Pygopterus Greenockii* of Agassiz. Since that time remains of the same fish have turned up in many other localities near Edinburgh, showing that it enjoyed a range extending upwards into the true Coal-measures. Proceeding upwards from the Wardie Shales, it occurs in the horizon of the Burdiehouse Limestone, a specimen in the British Museum (no. 45867) from Burntisland, in Fifeshire, displaying numerous scales and bones of this species, commingled with similar relics of *Eurynotus crenatus*. Numerous specimens also in the Edinburgh Museum of Science and Art, and in private collections, show its not uncommon presence in the "Edge-Coal" strata of Gilmerton and Loanhead, and in the Upper Coal-measures of Shawfair. With the exception of a head, with the anterior part of the body, from Gilmerton, belonging to Mr. Somervail of Edinburgh, and an entire though badly preserved specimen from Woolmet, near Edmonston, in the Museum of Science and Art, all the specimens as yet procured from beds above the Wardie Shales are very fragmentary; yet some of the fragments, from the softer nature of their matrix, afford us some details regarding the

\* Communicated by the Author, having been read before the Geological Society of Edinburgh, 4th February, 1875.

† "Description of *Pygopterus Greenockii*, Agass., with Notes on the Structural Relations of the Genera *Pygopterus*, *Amblypterus*, and *Eurynotus*," Trans. Royal Soc. Edinb. vol. xxiv. 1867, pp. 701-713, pl. xlv.

teeth and scales, which it is difficult to obtain from those preserved in the refractory ironstone of the Wardie nodules.

In his very brief notice of this fish\* Agassiz stated that, though very distinct as a species, its generic relations were doubtful, mentioning as a reason that the scales were much higher than broad. Having, since my previous description was written, enjoyed better opportunities of studying the characters of the genus *Pygopterus*, I have found the conclusion inevitable, that Agassiz's doubts were so well founded that it becomes absolutely necessary to erect a new genus for the fish under consideration. I propose, then, for it the generic title of *Nematoptychius*, in allusion to the fine thread-like striae with which the scales and many of the head-bones are ornamented.

As regards the scales, these differ in a most marked manner from those of *Pygopterus*. In the latter genus they are regularly rhomboidal (Pl. XVI. fig. 6); and over the greater part of the body they are equilateral, those in the front of the flank only being rather higher than broad. The exposed rhombic surface has its acute angles pointing, as usual, upwards and forwards, downwards and backwards; the anterior-superior angle is produced into a prominent point covered by the adjoining scale; while from the middle of the upper margin a special and well-marked articular peg or spine likewise rises, to be received into a corresponding depression on the under surface of the scale above. In fact Agassiz describes the scales of *P. mandibularis* as being very firmly articulated by means of "deux cornes, qui existent au bord supérieur de l'écaille, et se logent sous la surface émaillée de l'écaille voisine" †. These "deux cornes" (the one a production of the anterior-superior angle of the scale, the other a special articular spine arising from its upper margin) are indeed, as every one knows, by no means specially characteristic of *Pygopterus*. In *Nematoptychius Greenockii*, however, the scale is of a very different and, in truth, most peculiar form (Pl. XVI. figs. 9, 10, 11). All along the back and flanks the scales are much higher than broad; the exposed area is indeed more or less rhomboidal; but the acute angles are here the posterior-superior and the anterior-inferior. The anterior-superior angle is not produced into an articular point, distinct from the proper articular spine, which latter, broad and triangular, arises from the entire upper margin of the scale. The exposed ganoid surface is ornamented by very delicate thread-like, wavy, branching and anastomosing ridges, which, in the

\* Poissons Fossiles, t. ii. pt. 2, p. 78.

† *Ibid.* p. 76.

scales of the flank, are subparallel and run more or less vertically down the scale, or between the two acute angles (fig. 9); on the scales of the back, however, they often follow a more irregular and flexuously contorted course (fig. 11).

The general contour of the fish, too, as shown in the figure illustrating my previous paper, differs considerably from that in *Pygopterus*. In such typical *Pygopteri* as *P. mandibularis* or *P. Humboldtii*, both dorsal and anal fins are placed much in front of the caudal; the dorsal is not particularly large for the size of the fish (in fact none of the fins are, save the caudal, which is truly tremendous); but the base of the anal is peculiarly extended backwards. On this latter peculiarity Agassiz dwells particularly in characterizing the genus; for he says, "mais ce qui caractérise plus particulièrement les *Pygopterus*, c'est qu'à cette caudale inéquilobe se joint une anale fort longue qui garnit le bord inférieur du corps sur une grande étendue"\*.

In *Nematoptychius Greenockii*, on the other hand, the dorsal and anal are considerably larger in proportion, and placed nearer the tail, and the anal fin may be said to be the exact counterpart of the nearly oppositely placed dorsal. Other fishes have indeed been named "*Pygopterus*," in which the peculiar character of the anal fin referred to is also absent, as, for example, in the very imperfectly known *P. Bucklandi* of the Burdighouse Limestone, of which Agassiz says that it is characterized by having its anal "très-rapprochée de la caudale"†. Whatever value, however, we may be inclined to place on the form and position of these fins in a more extended revision of the genus *Pygopterus*, the form of the scales alone is certainly abundantly sufficient to distinguish *Nematoptychius* generically, not only from *Pygopterus*, but from all the other known genera of the family of Palæoniscidæ.

In my former communication the *teeth* were imperfectly described, it being very difficult to obtain satisfactory views of them in the Wardie specimens, owing to the hardness and peculiar nature of the ironstone in which they are enclosed. Specimens from Loanhead, however, preserved in soft bituminous shale or in cannel coal, afford better opportunities for studying their configuration (Pl. XVI. fig. 8). They are acutely conical, round in transverse section, and more or less curved inwards. Their apices very distinctly display the well-known "enamel cap" clearly marked off on the exterior of the

\* Poissons Fossiles, t. ii. pt. 2, p. 74.

† *Ib.* p. 77. I cannot refrain from expressing very considerable doubts as to that species, or, in fact, any other of the so-called Carboniferous "*Pygopteri*," being really referable to that genus.

tooth, so as to present an appearance almost as if a little extinguisher had been stuck on to the point. Below this, which is quite smooth, the polished surface is ornamented with fine striæ, more marked in some specimens than in others, and which consist, in fact, of very delicate linear depressions, often interrupted and wavy. These are best marked just below the enamel cap, and become lost towards the base of the tooth, which is dull and smooth. Microscopically the teeth display a structure quite similar to that described by Agassiz in *Pygopterus*, and by Messrs. Hancock and Atthey in *Palaoniscus Egertoni*. The pulp-cavity is simple and wide at the base, becoming attenuated upwards into the body of the tooth; the dentine displays the same arrangement of radiating tubules, and is crowned above by a cap of structureless "enamel," which also sends down a very thin and delicate layer over the whole external surface. I formerly described the teeth as quite smooth; and so they seemed to be in the specimen then at my disposal. The apparent absence of the striæ in these Wardie specimens, however, is evidently due to flaking-off of the external enamel film above mentioned, the surface being at the same time left rather dull; and I have since seen specimens from that locality in which the external polished surface still remains, and which show the very same striæ as those seen in specimens from other localities, preserved in a softer matrix.

The maxillary bone, represented in Pl. XVI. fig. 7, is from Shawfair, and, though undoubtedly belonging to the same species, is proportionally shorter and broader than is usually the case. I have another from Loanhead, which shows the same peculiarity. Neither of these belonged to full-grown fish, in which the maxillary often attains a length of  $2\frac{3}{4}$  inches by 1 inch in breadth posteriorly. The teeth are of different sizes; the larger ones, measuring in ordinary specimens from  $\frac{1}{5}$  to  $\frac{1}{4}$  inch in length, are arranged in a row at somewhat irregular intervals; and occupying a more external position on the edge of the jaw is a line of smaller teeth, whose length varies from about  $\frac{1}{16}$  to  $\frac{1}{8}$  inch. Certain specimens from Shawfair and Woolmet appear to have undergone much pressure, the bones and scales being very thin, though retaining their markings as distinctly as ever, and the teeth being considerably flattened, especially at their bases, as might have been expected. In these instances, however, the enamel cap remains unaffected, standing out all the more distinctly, while the striæ on the body of the tooth are also more strongly marked. These appearances are, I think, certainly due to changes occurring during fossilization, and not to specific difference.

The principal characters of the genus may be summed up as below :—

NEMATOPTYCHIUS, Traq., = *Pygopterus*, Ag., partim.

Body slender; head large, with bluntly pointed projecting muzzle; orbit far forward; gape very wide, with powerfully developed jaws; operculum rather small. Dentition powerfully developed; teeth of two principal sizes, acutely conical, and enamel-tipped. Pectoral and ventral fins moderate; rays of the pectoral articulated; dorsal and anal fins nearly equal, large, triangular; dorsal situated nearly opposite the anal; tail completely heterocercal; fin-fulcra small. Scales very peculiar in form; those of the flanks much higher than long, with a flat triangular articular process arising from the whole, or nearly the whole, upper margin; anterior-superior and posterior-inferior angles of the exposed face of the scale obtuse; ornament consisting of fine closely set thread-like ridges.

*Nematoptychius Greenockii*, Ag., sp.—The only species of the genus, and as yet only obtained from the Scottish Carboniferous strata.

For further details as to the general configuration and structure of this fish, including the osteology of the head, I must refer the reader to my previously quoted memoir in the 'Transactions of the Royal Society of Edinburgh.'

## II. *Wardichthys cyclosoma*, gen. et sp. nov.

This little fish, in my own collection, is contained in a nodule of clay ironstone from the shales at Wardie, and was found on the beach there, about fifteen years ago. It is entire, with the exception of the tail, which is unfortunately wanting. The body, including the head, measures 3 inches in length by  $2\frac{1}{4}$  at its greatest depth, and is remarkable for its nearly circular outline, and especially for the highly arched contour of the back, the ventral margin being much less curved. Fig. 1, Pl. XVI., represents the "counterpart" or impression of the specimen, which, however, will convey a better idea of the form of the fish than the other half of the nodule, as from the latter a little bit of the back unfortunately splintered off and was lost in the act of splitting it open.

The head equals about  $\frac{1}{3}$  the total length, without the tail; it is a little crushed over towards the right side, and a good deal of displacement seems to have taken place with the facial bones, only a few of which are recognizable. The cranium proper is short, the snout blunt and rounded as in *Mesolepis*; and the



orbit seems to have been well forward, as in the last-named genus. In Pl. XVI. fig. 2 I have indicated in diagrammatic outline the various bones which may be distinctly made out. Behind we have a pair of *parietals* (*p*), in front of which are the more elongated *frontals*, of which the impression of the right one (*f*) is seen; on the outer side of the parietal is a plate (*sq*), which answers to the *squamosal*, in front of which, and external to the frontal, is another (*p.f*) which may be reckoned as the *post-frontal*. The bones of the ethmoidal region, forming the short rounded snout, are too much crushed for description. All these cranial bones, as shown by their impressions, were ornamented by beautiful branching and anastomosing flexuous ridges; the impressions of their internal surfaces, shown by removing the friable bone from the other half of the specimen, display lines radiating from the ossific centres; and here also a groove, traversing longitudinally the frontal and parietal, betrays the course of the usual slime-canal. Very little is seen of the facial bones. A portion of the *hyomandibular* (*h.m*) is seen passing downwards and slightly backwards from under the squamosal, and seems to have been a rather slender bone like that of *Palæoniscus*. The *operculum* (*op*) is shaped much like that of *Mesolepis*, being four-sided, rather higher than broad, and with round posterior-superior and posterior-inferior angles; it is evidently displaced somewhat upwards and backwards. Below it is the *suboperculum* (*s.op*), also displaced and apparently a little turned round, so that what I conceive to be its upper margin comes in fact to look as much forwards as upwards. The only other recognizable facial bone is the *maxilla* (*mx*), a plate of considerable size, gently convex externally and broader behind than in front; its external surface was ornamented by wavy ridges very similar to those on the cranial bones. The lower jaw and branchiostegal rays are, unfortunately, not discoverable, nor have I been able to detect any trace of teeth.

*Shoulder-girdle*.—The *first supraclavicular* (*suprascapular*, Owen) is a very large, nearly square-shaped plate (*1st s.cl*), which is placed behind the parietal, and is apparently in contact at the middle line with its fellow of the opposite side. By its lower margin it articulates with the *second supraclavicular* (*scapular*, Owen), also of considerable size. This bone (*2nd s.cl*) is vertically oblong in form, rather broad above, where it is obliquely traversed by the lateral slime-canal before that tube enters the scales of the lateral line, and narrowing down to a point below. I exposed the whole of it by sacrificing and chiselling off the operculum (which covered a large part of it), as the whole contour of the last-mentioned bone is so well seen

in impression on the half of the nodule represented in fig. 1. In the diagrammatic outline, fig. 2, the second supraclavicular is seen largely covered by the somewhat displaced operculum. Both supraclaviculars agree very closely in form and position with the corresponding bones in *Mesolepis*, as seen by comparison with a very beautiful and perfect specimen of *M. scalaris*, Young, kindly lent me by my friend Mr. Ward. Some traces of an elongated clavicle are also seen, but not sufficiently marked for description.

*Fins*.—The specimen shows no trace of either pectorals or ventrals. The *dorsal* fin is small, and commences considerably behind the centre of the arch of the back; it is composed of numerous closely set rays, divided by very frequent transverse articulations. The most anterior rays are very short, but they increase rapidly in length to the ninth or tenth, from which the margin of the fin again falls away, so that it becomes more fringe-like posteriorly, where the rays are seen also repeatedly to bifurcate. Traces of fine fulcra are seen on the anterior margin. On the opposite aspect of the body some remains of the anal fin are seen—unfortunately only a few broken rays; yet from these we may pretty safely conclude that it corresponded in size and position to the dorsal.

*Scales*.—The scales of the side of the body are high and narrow, diminishing very regularly in size from before backwards. Their form is rhomboidal, the acute angles being the posterior-superior and the anterior-inferior. The external surface of each presents a well-defined, smooth anterior margin, produced downwards into the lower acute angle or point of the scale, overlapped by the scale in front, and corresponding to the thickened articular rib on the internal aspect. The latter is by no means strongly marked: it passes above into a pointed articular spine of moderate size; and below, it is obliquely bevelled off behind for the articular depression which receives the corresponding peg of the scale next below. The exposed surface is ornamented by a beautiful granular tuberculation, the little tubercles sometimes being arranged in lines or coalescing into short ridges, whose direction is always more or less *across* the scale, some tendency to radiation downwards towards the posterior-inferior angle being also often observed towards the lower part. This tendency of the tubercles to coalesce into transverse ridges is most pronounced in those scales which are situated more posteriorly (Pl. XVI. fig. 3), though I observe it also in one placed just behind the lower part of the suboperculum. The two scales represented in fig. 3 are from the lateral line, a little in front of the origin of the dorsal fin; they are seen to be each marked with

a slight notch on the posterior margin, and are evidently obliquely perforated by the lateral slime-canal.

Towards the dorsal and ventral margins the scales get considerably lower than on the flanks. Those represented in fig. 5 (also magnified two diameters) are from a situation further to the front of the fish than those from which fig. 3 was taken—namely, from the belly, a little distance behind and below the suboperculum. In them the articular spine is very broad and triangular, arising from the entire upper margin of the scale, and showing besides a few peculiar grooves on the surface, radiating from the middle of the base.

The foregoing description of the configuration of the scales has, together with the illustrative drawings, been principally taken from impressions left on the hard ironstone after very careful removal of the friable osseous matter, and from accurate “squeezes” in modelling-wax taken from the same.

*Conclusion.*—From the foregoing description it is at once evident that the little fish just described belongs to the Palæozoic section of Dr. Young’s suborder of *Lepidopleuridæ*; but it can hardly be included in any previously described genus. Necessarily leaving dentition out of consideration, the shape of the body and the relations of the dorsal fin alone widely distinguish it from *Mesolepis* and *Amphicentrum*. From *Platysomus* it is also separated by the form of the head, with its short blunt snout and relatively more anteriorly placed orbit, as well as by the nature of the scale-ornament, which in all the described species of *Platysomus* consists of fine vertical or slightly diagonal ridges or striæ. In the typical *Platysomi* too (*e. g.* *Pl. gibbosus, striatus*) “the dorsal fin commences at the *culminating point* of the dorsal ridge, and extends thence to the upper lobe of the caudal fin, the component rays diminishing very gradually in length from first to last;” moreover it contains “from 80 to 100 fin-rays”\*; here, on the other hand, the dorsal fin commences very much behind the highest point of the back and contains considerably fewer rays, though their exact number is not ascertainable. There only remains the very imperfectly known genus *Cleithrolepis*, Egerton†, from beds of doubtful Carboniferous age in New South Wales, and which, to certain points of resemblance to *Platysomus*, adds the peculiarity of having a homocercal tail; this organ, being absent in our specimen, is not available as a means of comparison. Although the rounded figure and posteriorly arising dorsal fin of *Cleithrolepis*, added to Sir Philip Egerton’s state-

\* Sir Philip Egerton, in ‘Quart. Journ. Geol. Soc. London,’ 1864, xx. p. 3.

† *Loc. cit.* p. 3, and pl. i. figs. 2 & 3.

ment that the scales are granulated, do remind us of the fish under consideration, yet so little is known of the structural details of the Australian fish, that all evidence of generic identity is wanting. As far as Sir Philip Egerton's description and figures go, however, the head of *Cleithrolepis* would seem to have been much smaller in proportion, the vertical rows of scales much more numerous, and the articulating rib on the anterior margin of the inner surface of each scale very considerably stronger. On the whole, I think it is better to bestow a new generic title on the present fish; and accordingly I propose for it the name *Wardichthys*\*, coupled with the specific designation *cyclosoma*.

WARDICHTHYS, gen. et sp. nov., Traquair.

Body flat, nearly circular, back very highly arched; dorsal and anal fins small, opposite, the former arising much behind the culminating point of the rounded dorsal arch and extending to the tail-pedicle. Pectoral, ventral, and caudal fins unknown, the latter probably heterocercal. Scales ornamented externally with fine tubercles, which often coalesce into short transverse ridges; lepidopleura weak. Snout short, rounded; orbit well forward; cranial bones ornamented by fine flexuous ridges or striæ.

*Wardichthys cyclosoma*.—The only known species; and of it, as yet, only one specimen has been obtained, from the Lower Carboniferous shales of Wardie (Newhaven), on the Frith of Forth, near Edinburgh.

III. *Rhizodus Hibberti*, Agass., sp.

A specimen of *Rhizodus Hibberti*, Agass., sp., from the blackband ironstone of Gilmerton, recently acquired by the Edinburgh Museum of Science and Art, throws some additional light on the structure of this remarkable and gigantic fish, concerning which so little is yet known in spite of the comparative abundance of fragmentary remains. It is a fragment of what would apparently have been a most magnificent and truly unique specimen, had the whole of it been obtained; as it is, it shows a portion of the head, shoulder, and anterior part of the body of an example of moderate, or rather small size, for a *Rhizodus* at least. The entire

\* In honour of Mr. J. Ward, of Longton, Staffordshire, to whom I am indebted for much valuable assistance in the study of Carboniferous fishes.

length of the fragment is 16 inches, and its greatest breadth 8 inches; in front there are some mutilated and unreadable remains of the head extending back for about 6 inches; but here a few doubly trenchant teeth of the well-known aspect and structure settle the question as to its being a *Rhizodus*. Behind these head-remains, and lying across the specimen, is a great part of a well-marked *clavicle*, resembling in shape that of *Holoptychius* and ornamented externally by reticulating ridges, furrows, and pits. The amount of it seen is  $5\frac{1}{2}$  inches in length; it is overlapped in front by some portions of head-bone, probably opercular; above, it is broken off at the edge of the specimen; and below, its termination is not very distinct, though I am rather disposed to think that another portion of bone coming on here is the *interclavicular*. The posterior margin shows a shallow excavation, from which issues a *pectoral fin*, obtusely or "subacutely" lobate in shape. The "lobe" is 3 inches long by  $1\frac{3}{4}$  broad; it is fringed with rays on the upper and posterior margins, some remains of them extending also a little round on the lower. The most perfect rays are those on the extremity of the lobe, where  $1\frac{1}{2}$  inch of their length is seen; they are slender, smooth, and very closely set; for an inch of their length they are unarticulated, after which transverse divisions are evident.

Behind the remains of the head and pectoral arch the specimen is covered by scales, which agree perfectly with those which we have been accustomed to refer to *Rhizodus Hibberti*. They lie for the most part undisturbedly *in situ*, deeply imbricating over each other, but, as usual, are mostly so split that only their internal structure, not their external sculpture, can be seen. One of these scales, just behind the upper end of the clavicle and pushed rather out of place, is seen to measure  $1\frac{1}{2}$  inch in length by  $1\frac{1}{4}$  in breadth; on the pectoral lobe the scales are very much smaller.

It is much to be regretted that the above-described fragment is all that has been saved of a specimen which was probably entire before the miner invaded its ironstone bed. Nevertheless the discovery of the pectoral fin of *Rhizodus* is of great interest, inasmuch as it furnishes us with another most important point of deviation of its structure from that of the Devonian genus *Holoptychius*, with which it was so long and so obstinately confounded. In *Holoptychius* the pectoral, as shown by Prof. Huxley, is long and very acutely lobate, like that of *Glyptolepis*; the obtusely lobate corresponding fin of *Rhizodus* shows that it must be placed apart from these, in a distinct subdivision of the great Glyptodipterine family, along with its smaller congener *Rhizodopsis*.

## EXPLANATION OF PLATE XVI.

- Fig. 1.* *Wardichthys cyclosoma*, Traq.; impression of right side of the fish, natural size.
- Fig. 2.* Diagrammatic outline of the recognizable bones of the head and shoulder: *p*, parietal; *f*, frontal; *sq*, squamosal; *pf*, post-frontal; *op*, operculum; *s.op*, suboperculum; *mx*, maxillary; *h.m*, hyomandibular; *1st s.cl*, first supraclavicular; *2nd s.cl*, second supraclavicular.
- Fig. 3.* Scales from the lateral line situated a little in front of a perpendicular from the commencement of the dorsal fin, magnified two diameters.
- Fig. 4.* Inner aspect of another flank-scale, magnified two diameters.
- Fig. 5.* Several scales from near the ventral margin, a little distance below and behind the suboperculum, also magnified two diameters.
- Fig. 6.* Inner surface of scale of *Pygopterus mandibularis*, Agass., magnified. After Sir P. G. Egerton, in King's 'Permian Fossils.'
- Fig. 7.* Outline of a peculiarly short maxillary bone of *Nematoptychius Greenockii*, Agass., sp. The contour is seen in impression, all the actual bone that remains is along the dental margin.
- Fig. 8.* Tooth of *Nematoptychius Greenockii*, seen from the outer side of the jaw, and magnified four diameters.
- Fig. 9.* Flank-scale of the same fish, magnified three diameters.
- Fig. 10.* Inner surface of a similar scale.
- Fig. 11.* Ornament of a group of four scales from the back of another specimen, also enlarged three diameters.

XXXV.—*Descriptions of new Species of Fish in the Collection of the British Museum.* By A. HALY.

*Hæmulon hians.*

D.  $\frac{12}{15}$ . A.  $\frac{3}{9}$ . L. lat. 50. L. transv.  $\frac{6}{12}$ .

The height of the body equals the length of the head, and is contained three times and a half in the total. The snout is of moderate length, rather longer than the eye, which is contained three times and a half in the length of the head. The cleft of the mouth is very wide, the maxillary reaching to the vertical from the centre of the eye. Præoperculum with the posterior limb nearly vertical, obtusely denticulated, the denticulations somewhat stronger at the angle. Dorsal deeply notched; the fourth spine longest, nearly half the length of the head, the last spine longer than the eleventh. Caudal forked. Second anal spine stronger but scarcely longer than the third, as long as the sixth dorsal spine. Pectoral one fifth of the total length. The fish appears to have been longitudinally striped.

Two specimens in spirits from Bahia, and a young stuffed specimen from the same locality. The adults are  $7\frac{1}{2}$  inches long.

*Pristipoma variolosum.*D.  $\frac{11}{16}$ . A.  $\frac{3}{10}$ . L. lat. 52. L. transv. 5/12.

The height of the body is contained three times, the head four times in the total length. The diameter of the eye nearly equals the length of the snout, and is contained three times and two thirds in the length of the head. The snout is rather short; the cleft of the mouth moderate; the maxillary extends to the front margin of the orbit. Præoperculum slightly sinuous posteriorly. The dorsal is deeply notched; the fourth spine longest, it is contained once and two thirds in the length of the head. Caudal slightly concave. Second anal spine very long and strong, longer than the fourth dorsal. Pectoral nearly one fourth of the total length. Silvery, the upper two thirds with brownish dots. Dorsal fin with a series of brownish spots along its base; dark spot on the opercle.

Two specimens from the Cameroons. The largest is  $7\frac{1}{4}$  inches long.

*Percis caudimaculatum.*

D. 5/21. A. 18. L. lat. 55.

The height of the body is contained seven times, the length of the head four times and a half in the total length. The diameter of the eye is twice the width of the interorbital space. The præoperculum is slightly denticulated. The ventrals do not reach to the origin of the anal. The central spines of the dorsal fin are the longest. Body with six vertical brown bands, interrupted by a lighter longitudinal line; a black spot at the upper angle of the root of the caudal.

Four specimens from North China. The largest is  $4\frac{1}{4}$  inches long.

*Sciæna margaritifera.*D.  $10\frac{1}{27-28}$ . A.  $\frac{2}{7}$ . L. lat. 74. L. transv.  $\frac{9}{15}$ .

The height of the body is contained four times or four times and a third in the total length, the length of the head about four times; the diameter of the eye is contained four times and a half in the length of the head. The length of the snout scarcely exceeds the diameter of the eye; it is slightly convex, with the jaws nearly equal in front. The upper maxillary reaches to the vertical from the posterior margin of the orbit. The upper jaw has an outer series of larger teeth. The præoperculum is rounded, finely denticulated; the operculum has two points. Caudal pointed. Anal spine feeble, one fourth of the length of the head. Coloration (in spirit) uniform; a

series of silvery spots along the lateral line; a black spot in the axil.

Two specimens from Port Natal. Length  $11\frac{1}{4}$  inches.

*Sphyræna Güntheri.*

D.  $5\frac{1}{2}$ . A.  $\frac{1}{3}$ . L. lat. 130. L. transv. 22.

The height of the body is one ninth of the total length; the length of the head is contained three times and two thirds in the total; the diameter of the eye is rather more than one seventh of the length of the head. The opercle has a single point; the opercles are scaly, and the præoperculum is rounded. The lower jaw with a short fleshy appendage anteriorly. The pectorals are contained nearly ten times in the total length; they are one third longer than the ventrals; the spine of the latter is nearly as long as the rays. The origin of the dorsal is on a level with the extremity of the pectorals, but somewhat behind the root of the ventrals, considerably in front of the middle of the length of the body. The interspace between the dorsals is equal to one seventh of the total length. The maxillary reaches to the anterior margin of the eye.

One specimen from Colon, Atlantic. Length 16 inches.

XXXVI.—*List and Revision of the Species of Anolidæ in the British-Museum Collection, with Descriptions of new Species.*

By A. W. E. O'SHAUGHNESSY, Assistant in the Natural-History Department.

SINCE the date of the publication of Dr. Gray's 'Catalogue of Lizards in the British Museum' large additions have been made to the collection of specimens of the group *Anolis*. Many of these additional specimens were examined by Mr. Cope some years since, and furnished him with the types of new species, which he described in the 'Proceedings' of the Academy of Natural Sciences of Philadelphia. The following list is the result of a recent study of the entire series, and gives the names of all the species which appear to me to be represented in it.

CHAMÆLEOLIS, Coct.

*Chamæleolis fernandina*, Coct., Sagra's Cuba, p. 145, t. xii.

*Anolis chamæleonicides*, Dum. & Bibr. Erp. Gén. iv. p. 168.

*Chamæleolis porcus*, Gundlach, Rep. fis.-nat. Cuba, ii. p. 109; Cope, Proc. Acad. Philad. 1864, p. 168.



## XIPHOSURUS, Fitz., Gray.

*Xiphosurus Ricordii*, Dum. & Bibr. *l. c.* p. 167; Gray, Ann. Nat. Hist. 1840, v. p. 111.

*Eupristis baleatus*, Cope, *l. c.* p. 168.

Two adult specimens, one being the type of Cope's *Eupristis baleatus*, which proves to be the same species. Both from San Domingo.

*X. cristatellus*, Dum. & Bibr. *l. c.* p. 143; Dum. Cat. Rept. 1851, p. 58; Reinh. & Lütke. Vid. Medd. 1862, p. 249.

There are now numerous specimens of this species in the collection.

*X. homolechis*, Cope, Proc. Acad. Philad. 1864, p. 169.

The type specimen is the single example referred by Dr. Gray to the preceding species. It is distinguished by a quite different scutellation of the upper surface of the head and muzzle—viz. smaller, irregular, and keeled, instead of the symmetrical flat plates. West Indies.

*X. ferreus*, Cope, Proc. Acad. Philad. 1864, p. 168.

The type, a large specimen, from Guadeloupe.

## DACTYLOA, Wagl.

*Dactyloa equestris*, Merr. Tent. p. 45; Dum. & Bibr. *l. c.* p. 157; Gray, *l. c.* p. 111.

*Anolis rhodolæmus*, Bell, Zool. Journ. iii. p. 235, t. xx.; Sloane, Jamaica, ii. p. 273, fig. 2.

The second specimen referred in Dr. Gray's Catalogue to this species is a *Urostrophus Vautiéri*.

*D. Edwardsii*, Merr. *l. c.* p. 45; Dum. & Bibr. *l. c.* p. 161; Dum. Cat. Rept. p. 59.

## RHINOSAURUS, Gray.

*Rhinosaurus gracilis*, Neuwied, Bras. tab. fig. 2, Voy. ii. p. 131; Wagl. Syst. p. 148 (*Dactyloa gracilis*).

*Anolis nasicus*, Dum. & Bibr. *l. c.* p. 115; Dum. Cat. Rept. p. 57.

## ANOLIS.

A. *With smooth ventral scales.*

*Anolis bimaculatus*, Sparrm. N. Act. Stock. v. p. 169, t. iv. fig. 1; Merr. *l. c.* p. 45.

*Anolis Leachii*, Dum. & Bibr. *l. c.* p. 153; Dum. Cat. Rept. p. 58, Gray, Cat. p. 200.

*A. maculatus*, Gray, Ann. Nat. Hist. 1840, v. p. 112.

*A. reticulatus*, Gray, Ann. Nat. Hist. 1840, v. p. 114; Cat. p. 204.

*A. alliaceus*, Cope, *l. c.* p. 175.

The types of the two latter are in the British Museum, and prove to be identical with the present species.

*A. punctatus*, Daud. Rept. iv. p. 84, t. lxvi. fig. 2; Dum. & Bibr. *l. c.* p. 112; Dum. Cat. p. 57.

*A. viridis*, Neuwied, Bras. fig. 1; Voy. ii. p. 132.

*A. violaceus*, Spix, Lac. Bras. p. 15, t. xvii. fig. 2.

The collection now possesses one adult specimen from Rio Janeiro.

*A. Cepedii*, Merr. *l. c.* p. 44; Gray, Cat. p. 201.

*A. alligator*, Dum. & Bibr. *l. c.* p. 134; Bocourt, Miss. Sc. Mex. iii. p. 59, note; Cope, Proc. Am. Phil. Soc. 1869, p. 162.

*A. trinitatis*, Reinh. & Lütke. Vid. Medd. 1862, p. 269.

*A. Goudotii*, Dum. & Bibr. *l. c.* p. 108 (type Mus. Par.).

*A. æneus*, Gray, Cat. p. 205.

The specimen described by Dr. Gray as *A. æneus*, presented by Th. Bell, Esq., is in my opinion a young specimen of *A. alligator*, Dum. & Bibr.

*A. lucius*, Dum. & Bibr. *l. c.* p. 105; Coct., Sagra's Cuba, p. 136, t. xii.

*A. argenteolus*, Cope, Proc. Acad. Philad. 1861, p. 213.

Previously to the specimens named *A. argenteolus* by Mr. Cope, this species was not represented in our collection; but after comparison with Cocteau's description, I cannot avoid referring them to *A. lucius*.

*A. chlorocyanus*, Dum. & Bibr. *l. c.* p. 117; Reinh. & Lütke. Vid. Medd. 1862, p. 266.

*A. (Ctenocercus) caelestinus*, Cope, Proc. Acad. Philad. 1862, p. 177.

Specimens from San Domingo, named *A. caelestinus* by Mr. Cope.

*A. fusco-auratus*, D'Orb. Voy. Amér., Rept. t. iii. fig. 2 ;  
Dum. & Bibr. *l. c.* p. 110 ; Dum. Cat. Rept. p. 56 ; Bocourt,  
Ann. Mus. vi. 1869, Bullet. p. 15, Miss. Sc. Mex. iii.  
pl. xiv. fig. 16.

*A. viridiæneus*, Peters, Monatsb. Berl. 1863, p. 147.

Hitherto unrepresented in the collection. Specimens from  
Para and Guayaquil.

*A. Grahamsi*, Gray, Ann. Nat. Hist. 1840, v. p. 113 ; Cat. Liz.  
pp. 203 & 274 ; Cope, *l. c.* 1861, p. 210, Proc. Am. Phil.  
Soc. 1869, p. 164.

*A. punctatissimus*, Hallowell, Proc. Acad. Philad. 1856, p. 225.

*A. heterolepis*, Hallowell, *l. c.* p. 230.

*A. iodurus* and *A. opalinus*, Gosse, Ann. & Mag. Nat. Hist. 1850, vi.  
p. 344.

It is important to establish the fact that Mr. Gosse's two  
species are the older *A. Grahamsi*, of which there would never  
have been any uncertainty had not Dr. Gray stated that the  
specimens on which he founded the species were from Dr.  
Gardner's Brazilian collection. The real entry in the register  
shows that he obtained them from a dealer named Gardiner  
without indication of a locality ; and there can be no doubt  
that they came from Jamaica, this species being one of the  
commonest in the island.

*A. acutus*, Hallowell, Proc. Acad. Philad. 1856, p. 228 ; Reinh.  
& Lütke. *l. c.* 1862, p. 252 ; Cope, *l. c.* 1861, p. 209.

*A. Newtoni*, Günth. Ann. & Mag. Nat. Hist. 1859, iv. p. 212, pl. iv.

? *Lacerta principalis*, West, Beytr. z. Besch. v. S. Cruz.

Numerous specimens from Santa Cruz and Dominica.

*A. gingivinus*, Cope, Proc. Acad. Philad. 1864, p. 170, and  
1871, p. 220.

The types (male and female) from Anguilla Island.

*A. distichus*, Cope, Proc. Acad. Philad. 1861, p. 208 ; Proc.  
Am. Phil. Soc. 1869, p. 164.

? *A. carbonarius*, Daudin.

*A. dominicensis*, Reinh. & Lütke. *l. c.* p. 261.

Specimens from the Copenhagen Museum and specimens  
named by Mr. Cope enable me to confirm his statement of  
the identity of the species.

*A. stratulus*, Cope, Proc. Acad. Philad. 1861, p. 209 ; Reinh.  
& Lütke. Vid. Medd. 1862, p. 255.

Numerous specimens from St. Thomas's Island.

*A. cybotes*, Cope, Proc. Acad. Philad. 1862, p. 177; Proc. Am. Phil. Soc. 1869, p. 164.

*A. Rüsei*, Reinh. & Lütke, *l. c.* p. 264.

Specimens (male and female) from San Domingo.

*A. gibbiceps*, Cope, Proc. Acad. Philad. 1864, p. 174.

The type (female) from Caracas.

*A. citrinellus*, Cope, Proc. Acad. Philad. 1864, p. 170.

The type from San Domingo.

*A. damulus*, Cope, Proc. Acad. Philad. 1864, p. 169.

The type presented by Dr. Günther.

*A. insignis*, Cope, *l. c.* 1871, p. 213.

A fine specimen, brought from Costa Rica by Mr. Salvin, agrees with Mr. Cope's recent description of this well-marked species.

*A. Bouvieri*, Bocourt, Miss. Sc. Mex. iii. p. 58, pl. xiv. fig. 8.

Three specimens from Pebas and Guayaquil. The tail, perfect, is compressed and has the upper edge serrated, as described by M. Bocourt.

*A. transversalis*, Dum. Cat. Rept. p. 57; Arch. du Mus. viii. p. 515, pl. xix. fig. 3; Guichen. in Casteln. Amér. du S., Rept. p. 17.

*A. impetigosus*, Cope, Proc. Acad. Philad. 1864, p. 174.

Mr. Cope's type, of which the habitat is unknown, being in the collection, I am able to refer it to the above species, described by Duméril.

*A. heterodermus*, Dum. *l. c.* p. 59, and *l. c.* p. 516, pl. xix. fig. 4.

Adult and half-grown specimens from Bogota enable me to add this other remarkable species, described by Duméril, to the list.

#### B. *Ventral scales keeled.*

*A. (Dactyloa) biporcatus*, Wiegman, Herp. Mex. p. 47; Bocourt, Miss. Sc. Mex. p. 98, pl. xv. fig. 8.

*A. (Draconura) vittigerus*, Cope, Proc. Acad. Philad. 1862, p. 179.

A single specimen from Rio Polochic, Guatemala, presented

by the Paris Museum, and numerous others named *A. vittigerus* by Mr. Cope. This species was referred by Dr. Gray to *A. principalis*.

*A. Fraseri*, Günth. P. Z. S. 1859, p. 407.

*A. bitectus*, Cope, *l. c.* 1864, p. 171.

A fine series, with some large specimens recently added. Some of the specimens have been named *A. pentapriion* and *A. vittigerus* by Mr. Cope; and the two types of his *A. bitectus* are also found to be the present species.

*A. Petersii*, Bocourt, Miss. Sc. Mex. iii. p. 79, pl. xiii. fig. 2, & pl. xv. figs. 11, 11a.

Two fine specimens and a young one in the collection are to be referred to this species. They are from Mexico.

*A. Sagrai*, Cocteau, Sagra's Cuba, Rept. p. 131, t. x.; Dum. & Bibr. *l. c.* p. 150; Dum. Cat. Rept. p. 58; Cope, *l. c.* 1862, p. 178, note; Bocourt, *l. c.* p. 81, pl. xv. fig. 14.

*A. ordinatus*, Cope, *l. c.* 1864, p. 175.

A large series, including the types of Mr. Cope's species, and those hitherto placed by Dr. Gray under *A. nebulosus*, Wieg., with which he confounded this species.

*A. maculatus*, Gray, Ann. Nat. Hist. 1840, v. p. 113; Cat. Liz. p. 203; Reinh. & Lütke. *l. c.* p. 268.

*A. lineatopus*, Gray, Ann. Nat. Hist. 1840, v. p. 113; Cat. Liz. p. 203.

This species has a great resemblance to the last, but the ventral scales are considerably larger. Numerous specimens are now in the collection from Jamaica; the type of *A. lineatopus* is the same species.

*A. pulchellus*, Dum. & Bibr. *l. c.* p. 97; Dum. Cat. p. 56; Reinh. & Lütke. *l. c.* p. 257.

Now well represented, from St. Thomas's Island.

*A. Richardi*, Dum. & Bibr. *l. c.* p. 141; Gray, Ann. Nat. Hist. 1840, v. p. 113; Cat. B. M. p. 202.

*A. occipitalis*, Gray, *l. c.* p. 112; Cat. Brit. Mus. p. 201.

*A. stenodactylus*, Gray, *l. c.* p. 114; Cat. Brit. Mus. p. 204.

All the specimens referred to or described by Dr. Gray under the above three heads belong to this species.

*A. principalis*, L.*A. carolinensis*, Dum. & Bibr. *l. c.* p. 121.*A. porcatus*, Gray, Ann. Nat. Hist. 1840, v. p. 112; Cat. Brit. Mus. p. 202.

The specimens described under the latter name are individuals of this species, with which the collection is now well supplied. It is not the *Dactyloa biporcata* of Wiegmann (as stated by Dr. Gray).

*A. nebulosus*, Wiegmann; Bocourt, Miss. Sc. Mex. p. 68, pl. xv. fig. 3.

One specimen recently acquired from Cuernavaca, those referred to this species by Dr. Gray being *A. Sagræi*, Coct.

*A. Sallwi*, Günth. P. Z. S. 1859, p. 405; Bocourt, *l. c.* p. 90, pl. xiii. fig. 3, pl. xvi. fig. 21.*A. cyanopleurus*, Cope, *l. c.* 1861, p. 211.*A. spectrum*, Peters, Berl. MB. 1863, p. 136.

Specimens from San Domingo and from Cuba.

*A. semilineatus*, Cope, *l. c.* 1864, p. 171.

The type from San Domingo.

*A. ophiolepis*, Cope, *l. c.* 1861, p. 211.

One specimen from Cuba, presented by Dr. Peters.

*A. Copei*, Bocourt, Miss. Sc. Mex. p. 77, pl. xv. figs. 10, 10a.

A fine specimen has been recently procured of Mr. Salvin from Costa Rica.

*A. nebuloides*, Bocourt, *l. c.* p. 74, pl. xiii. fig. 10.

Two specimens from Huamuchla, from Mr. Boucard.

*A. crassulus*, Cope, *l. c.* 1864, p. 173.

The types and other specimens. Central America.

*A. nannodes*, Cope, *l. c.* p. 173; Bocourt, *l. c.* p. 71, pl. xv. fig. 5.

The types and one other example, from Coban.

*A. ustus*, Cope, *l. c.* p. 172.

The types from Belize.

*A. cymbops*, Cope, *l. c.* p. 173.

The type from Vera Cruz.

PLACOPSIS, Gosse.

*Placopsis Valenciennii*, Dum. & Bibr. *l. c.* p. 131.

*P. ocellata*, Gosse, Ann. & Mag. Nat. Hist. 1850, ii. p. 346.

*A. leucocephalus*, Hallow. Proc. Acad. Philad. 1856, p. 226.

*Xiphocercus Valenciennii*, Cope, *l. c.* 1861, p. 215.

ACANTHOLIS, Coct.

*Acantholis Loysiana*, Coct. *l. c.* p. 141; Dum. & Bibr. *l. c.*  
p. 100; Bocourt, *l. c.* p. 69, pl. xiv. fig. 9.

? *A. argillaccus*, Cope, *l. c.* 1862, p. 176.

One specimen from Cuba, presented by Dr. Peters.

NOROPS, Wagl.

*Norops auratus*, Wagl. Syst. p. 149; Wieg. *l. c.* p. 16;  
Dum. & Bibr. *l. c.* p. 82, pl. 37; Bocourt, *l. c.* p. 108,  
pl. xiii. figs. 5, 5a, pl. xvi. fig. 33, a, b.

*A. perissurus*, Cope.

There are now five adult specimens in the collection, one of which is the "type of *A. perissurus*, Cope."

*N. tropidonotus*, Peters, Berl. Monatsb. 1863, p. 135; Bocourt,  
*l. c.* p. 103, pl. xiii. fig. 6, pl. xvi. fig. 30.

A large series of examples is now added to the collection.

Having found that the specimen referred in Dr. Gray's catalogue to *Draconura chrysolepis* is really *Norops auratus*, I am now enabled to recognize this well-marked species, the examples of which I had supposed to be *N. auratus*. (See 'Annals,' 1869, iii. p. 183 &c.)

DRACONURA, Wagl.

*Draconura nitens*, Wagl. *l. c.*; Peters, *l. c.* 1863, p. 142.

*A. refulgens*, Schleg.; Dum. & Bibr. *l. c.* p. 91.

Three adult specimens from Pebas, collected by Mr. Bates.

*D. catenata*, Gosse, Ann. & Mag. Nat. Hist. 1850, ii. p. 344.

The type from Jamaica.

*D. chrysolepis*, Dum. & Bibr. *l. c.* p. 94; Guichen. Casteln. Amér. ii. p. 15, pl. iv. fig. 1; Bocourt, *l. c.* p. 99, pl. xvi. fig. 26.

*A. scypheus*, Cope, *l. c.* 1864, p. 172.

The specimen referred in Dr. Gray's Catalogue to this species is a *Norops auratus*. There are now two adults from Caracas and the Amazons, one of which is the type of Mr. Cope's *A. scypheus*.

*D. capito*, Peters, Berl. Monatsb. 1863, p. 142; Bocourt, *l. c.* p. 101, pl. xvi. fig. 27.

*A. carneus*, Cope, *l. c.* 1864, p. 171.

Two fine specimens (male and female) from Vera Paz, collected by Mr. Salvin; the types of Mr. Cope's *A. carneus*.

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*Anolis nummifer*, sp. n.

Head a little shorter than tibia, its breadth two thirds of its length. Hind limbs long, reaching beyond the tip of the snout. Ear-opening not half the longitudinal diameter of the eye. Lateral canthus of muzzle sharp. Scales of muzzle roundish or polygonal, irregularly ridged, sometimes tricarinate; supraorbital ridges separated by two rows on the vertex, widely divergent anteriorly. Supraocular disk composed of about fifteen polygonal keeled scales, bounded externally by granules. Occipital large, elongate, with the angles rounded, half the length of the eye, with central tubercle. Scales of body very convex, granular, becoming modified into keeled scales on the central regions of the back, but scarcely increasing in size. Scales of lower surface larger, regularly arranged, rounded and keeled; of limbs keeled externally, granular internally. Tail not broadened at the base, round; scales small, keeled. Goitre very slightly developed. Digital expansions well developed.

Colours: above bronzed brown; a brown stripe across the orbital region. Sides with large round dark spots, extending in the form of dots on the lower surface of body and limbs; the latter viridescent. *Female* with bright longitudinal dorsal stripe.

Several specimens in the collection of the British Museum, from the Demerara Falls.

*Anolis turmalis*, sp. n.

Head a little shorter than tibia, shaped as in the last.



Scales of muzzle either convex only or indistinctly keeled. Supraorbitals separated on vertex by two rows of scales. Occipital large, ovate, larger than the ear-opening, and half the length of the eye. Polygonal scales of supraocular disk numerous, convex or weakly keeled. Infraorbitals two rows. Form elongate, slender. Hind limb reaching to or beyond extremity of muzzle. Several series of regular keeled scales on middle of back, larger than the granules which cover the sides, but smaller than the ventral scales, which are ovate and keeled. Tail long, rounded, covered with scales like those of the belly. Digital expansions well developed.

Colours: bronzed brown above; an orbital transverse stripe; lower surface viridescent; darker variegations on the back, taking the form of oblique streaks on the sides, as in *Draconura chrysolepis*.

Specimens in the British Museum from the island of Grenada.

*Anolis tessellatus*, sp. n.

Resembles *A. transversalis*. Head not quite twice as long as broad, no frontal concavity; covered with large polygonal flat scales; the supraorbitals in contact; the occipital large, but separated from these by several scales; the occipital region bounded triangularly by feebly raised ridges. Ear-opening small, round. Scales of back and sides polygonal or roundish, smooth; of belly larger, oval, imbricated, and keeled; those of the tail similar.

Digital dilatations narrow.

Colour: green, with brown markings on back and tail.

Specimen in the British Museum, collected by Mr. Salvin in Costa Rica.

*Anolis lentiginosus*, sp. n.

Head short, broad, obtuse, much shorter than tibia, its width being two thirds of its length; its height at the orbital region nearly equal to its width. Scales of the front and muzzle small, strongly tricarinate; of occipital region very numerous, polygonal, flat, the occipital itself being scarcely distinguishable in their midst. Supraorbital borders composed of numerous small-sized scales, separated by one or more scales on the vertex, and elsewhere rapidly and widely divergent. Nearly the whole of the supraocular space covered by about twenty rather small keeled or rugose scales. Scales of middle dorsal region larger than those of the sides, and increasing in size gradually from the neck to the tail; they are striate, presenting where the epidermis is preserved the appearance of being tricarinate; continuing on the tail they become distinctly

keeled scales. Scales of the sides granular; of the belly larger than those of the back, ovate, strongly keeled. Hind limbs long, reaching considerably beyond the end of the muzzle. Digital expansions moderate. Ear-opening small, round. Tail broad at the base, somewhat compressed, rounded above. Goitre very small.

Colour golden brown, freckled above with dark brown; a dark patch on the muzzle and a transverse orbital stripe; two brown lines across the back before the root of the tail, and some oblique ones on the tibiae.

One specimen in the British Museum from Surinam, collected by Mr. Kappler.

*Anolis gemmosus*, sp. n.

Elongate, slender. Head narrow, of about the same length as the tibia. Hind limb reaching to end of snout. Tail very long and tapering, three times the length of the head and body. Upper surface of the head entirely covered by polygonal rugose scales, very numerous and closely set, small on the muzzle and prefrontal regions, where they converge to the central concavity, which is feebly and gradually formed; larger, but of similar character, on the vertical and occipital portions, there being no conspicuous ridges on any part of the head; occipital scale as small as the others. Ear-opening small, vertical. Upper surface of body, including the sides, uniformly covered by minute convex granules; ventral surface with equally uniform minute polygonal or rounded flat scales: the tail with minute keeled scales. Toes and claws slender, the expansions well developed.

Colours prettily variegated. Ground-colour above apparently a lustrous brown, with blue and violet reflections; a series of glittering spots like arrow-heads pointing forwards along median line of back, and numerous ring-like ocelli on the sides, the sides of the belly and lower surface of the limbs being regularly ocellated, and the chin variegated; upper surface of limbs banded and spotted.

This species presents a resemblance to the *Draconura nitens*, which differs from it in the size and proportions of the head, and in the strongly keeled scales of the muzzle, size of the occipital, and other points.

One specimen in the British Museum, the habitat of which is not indicated.

*Norops onca*, sp. n.

Head somewhat longer than tibia. Scales of muzzle convex and multicarinate, numerous; those of the supraorbital series

not much larger nor greatly raised, separated by several rows of convex scales; the occipital distinct, and larger than the surrounding scales, but small, elongate; a slight pit or depression on the region behind it. Two or three series of larger keeled scales on the superciliary space. Ear small, narrow, not much larger than the occipital.

Scales of the back small, keeled; of the side elongate, oval, convex; of the belly larger than those of the back, keeled; of the tail like those of the back and belly; of the limbs also keeled. The hind limb reaches to the eye; the fore limb the length of the side. The toes are not dilated. Goitre very large, extending nearly to the middle of the abdomen.

Colour pale brown, variegated with darker, in the form of large rhombic spots, open in the middle, along each side of the median line of the back; dark spots and streaks also on the sides, head, and limbs.

Specimens in the British Museum from Venezuela and Dominica.

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XXXVII.—*Biographical Notice of the late Dr. JOHN EDWARD GRAY.*

It is our painful duty this month to record the death on the 7th ultimo of Dr. John Edward Gray, F.R.S. &c., who has been for the last seventeen years one of the Editors of this Journal.

Dr. Gray was born at Walsall in the year 1800; so that at the time of his death he had just completed his 75th year. He was the son of Mr. S. F. Gray, the author of the well-known 'Supplement to the Pharmacopœia,' and the grandson of Mr. Samuel Gray, a seedsman in Pall Mall, who possessed considerable scientific knowledge, translated the 'Philosophia Botanica' of Linnæus for his friend Mr. Lee, of Hammersmith, and assisted him in the composition of his 'Introduction to Botany,' which first made known the labours of the great Swedish naturalist to English readers. Dr. Gray may thus be regarded as belonging to a family in which natural-history tastes were hereditary.

According to his own account he was a weakly and ailing child, confined to his chair for eight months in the year, and never eating animal food. At a very early age he says he began the world, to provide for himself and help his family. He was originally intended for the profession of medicine; but his studies were very early turned specially to natural history;

in 1819 he had joined the London Philosophical Society, which numbered the late Mr. Faraday among its members, and in 1820 he was a member of the Philosophical Society of London, a society established in 1810 under the patronage of the Duke of Sussex,

The old Entomological Society of London, the successor of the Aurelian Society, established in 1806, at this time held its meetings at No. 87 Hatton Garden; and in 1822 Dr. Gray became a Fellow and Secretary of that Society, which was soon afterwards expanded into the Zoological Club of the Linnean Society. As the Fellowship of the Linnean Society was an essential qualification for being a member of the Zoological Club, John Edward Gray was excluded from it; for although he had been proposed as a Fellow of the Linnean Society by such men as Haworth, Vigers, J. F. Stephens, Joseph Goodall, Latham, Griffith, and Salisbury, he was rejected by a large majority in a very full meeting, on the 16th of April, 1822. It is of course impossible now to ascertain the precise reasons for the rejection of a young naturalist who had already given evidence of no ordinary powers and attainments both in zoology and botany. Dr. Gray himself has suggested that his certificate, bearing "the names of at least four naturalists anxious to improve zoology and botany, may have frightened the regular 'Linnaeans,' of whom Dr. Shaw may be considered a fair example. He proposed putting his heel on or, as some say, breaking with a hammer all shells not in the twelfth edition of Linnaeus's 'Systema Naturæ.' Things not in Linnaeus ought not to exist." Such views as these are undoubtedly very narrow; but, supposing them to exist, the policy of preventing the opposite party from gaining an accession of strength in the person of the young candidate would be intelligible, and to a certain extent respectable. But the reason actually assigned for his rejection was paltry. He was accused of having insulted the President of the Society, Sir James Edward Smith, by quoting the 'English Botany' as Sowerby's, Sir James having been hired by Sowerby to write the text for his plates.

We should not have dwelt so long upon this miserable history but for the circumstance that, whatever may have been the cause of his rejection, the fact itself certainly had a great influence upon Dr. Gray's character. One can easily understand that the circumstance of being thus ignominiously rejected must have been a bitter disappointment to a young and enthusiastic naturalist such as Gray then was; and we cannot wonder that he placed himself in decided antagonism to those whom he thought his enemies in the matter, and thus acquired that combative habit of mind which undoubtedly

in after life procured him many "unfriends." In 1826 the Zoological Club was developed into the Zoological Society, which Dr. Gray at once joined, and he was one of its most active Fellows until ill health confined him to his house.

In the mean time, in 1824, he had become an assistant in the Natural-History Department of the British Museum, of which he was appointed Keeper in 1840, on the resignation of Mr. Children. With this great national establishment his life has since been inseparably connected.

In 1826 he married the widow of his cousin, the only son of Dr. E. W. Gray, his granduncle, a former secretary of the Royal Society; and this lady, who survives to mourn his loss, assisted him in all his subsequent labours, and is herself the author of the well-known 'Figures of Molluscous Animals.'

For more than fifty years Dr. Gray's life was one of unceasing activity. Considerably more than a thousand books, memoirs, and notes on almost all departments of zoology, attest the extraordinary versatility and energy of his mind; and his earliest efforts, when little more than a boy, were devoted to the kindred science of botany, in which he, with the cooperation of his father, was the first to introduce the Jussieuan Natural System to English botanists. It may be a question whether his efforts for this purpose, in the 'Natural Arrangement of British Plants,' were not the cause of that ignominious rejection by the Linnean Society of which we have already spoken.

But even the exertions necessary to produce the vast mass of written zoological papers which bear his name did not exhaust his activity; and we find him showing a strong interest in such varied matters as sanitary and metropolitan improvements, education, prison discipline, and the abolition of imprisonment for debt, the improvement of the treatment of lunatics, and the opening of museums, libraries, picture-galleries, and gardens to the public. Dr. Gray claimed to have been the original proposer of the system of a low uniform rate of postage to be prepaid by stamps—a system carried out by Rowland Hill, and now adopted all over the world. He took much interest in the question of the adoption of a decimal scale of coinage, weights, and measures in this country; and between 1854 and 1857 published numerous articles and pamphlets on this subject. His opinion was that if a decimal system were to be adopted, it should be organized on the principle of making the larger coins decimal multiples of a small existing unit, such as the penny, instead of decimal divisors of a large unit, such as the pound.

In considering the immense mass of work published by Dr. Gray, the zoologist may sometimes be inclined to wish that

its amount were less, and that the author had given himself more time for the full elaboration of the various subjects that he took up. In too many instances he hastened to put the results of his researches into shape before he had really completed them; hence further investigations led him to modify the views which he had expressed only a short time previously, and thus two or three papers on the same subject, perhaps the classification of some tribe or family of animals, would follow each other in rapid succession. It would undoubtedly have been better, both for zoology and for his own future fame, if the outcome of the same amount of study had been represented by half, or even a quarter, of the amount of literature which now stands in Dr. Gray's name. But there is one labour of his from which no such deduction is to be made; and it is this especially that will carry his name down the stream of time. From his appointment as an Assistant in the British Museum until the close of his life, but more especially since his having been made Keeper of the Natural-History Department, he devoted himself with unflagging energy to the development of the collection under his charge; and mainly by his exertions it has grown from the rudimentary state in which it existed in the days of Dr. Leach, to the magnificent proportions which it has now attained. It is impossible to overrate the services rendered to zoology in this country by Dr. Gray in the accumulation of the fine series of specimens now possessed by the British Museum, and the excellent catalogues of several departments prepared by him or under his auspices. His knowledge of species and genera in those groups to which his attention was particularly directed was perhaps unrivalled; his great energy and administrative ability enabled him to carry out the business of his department in the face of difficulties and obstacles which few would have overcome. His great services in this respect met with more direct recognition abroad than in this country: in 1852 he received the honorary degree of Doctor of Philosophy from the University of Munich; and in 1860 the large Gold Medal of merit was conferred upon him by the King of Württemberg, on his declining the offer of an order of knighthood which had been made to him. His merits were also acknowledged by many foreign Societies and Academies, which enrolled him in the lists of their honorary and corresponding members. The Academy of Natural Sciences of Philadelphia paid him this honour as early as 1829; and he was subsequently elected to analogous positions by scientific bodies in Boston, Moscow, Rome, Paris, Darmstadt, Lyons, Turin, Strasbourg, Lund, and other places. He was also a Fellow or Member of nearly all the Natural-History Societies in London.

We are conscious that these few and imperfect remarks are far from doing justice to the merits of Dr. Gray. For more than fifty years he occupied a position in the first rank of the naturalists of this country, and both in his capacity as Director of the chief zoological collection in Britain and by his personal exertions in various ways, he exercised a widespread influence. He was always ready to facilitate the study of the splendid collections under his charge, and to give advice and assistance to earnest students; and whilst it must be admitted that the shrewdness of his character, which led him to penetrate the hidden motives of men, coupled with an acquired or natural causticity of manner, often raised a prejudice against him, those who succeeded in getting within the outworks thus raised, found in Dr. Gray a warm-hearted, judicious, kind, and firm friend.

## BIBLIOGRAPHICAL NOTICE.

*Zoology.* By ALFRED NEWTON, M.A., F.R.S. Sm. 8vo. London, 1874. Society for Promoting Christian Knowledge.

*The Student's Guide to Zoology, a Manual of the Principles of Zoological Science.* By ANDREW WILSON. Sm. 8vo. London: J. & A. Churchill, 1874.

We have already, on more than one occasion, noticed the great fertility of the present day in zoological manuals. Up to within a very few years the student had the choice of two or three English books on the subject, and that was all; now his difficulties must arise solely from an *embarras de richesses*, seeing that the number and variety of the manuals offered for his selection is so great that he ought to be able to suit himself perfectly, if only he knows how to choose.

The two little handbooks of which the titles stand at the head of this article do not profess to furnish a regular system of zoology; they are devoted to the exposition of the principles of the science, or, in other words, the generalization of the results obtained by zoological investigation, to form a basis for future studies. The first of them, by Professor Alfred Newton, is one of a series of shilling 'Manuals of Elementary Science' published by the Society for Promoting Christian Knowledge; and it reflects high credit both on its author and on the Society under whose auspices it has been produced. The leading branches of zoological study are explained very simply and clearly, and from a really zoological stand-point, by Prof. Newton, whose lessons might, we think, be taken to heart with advantage by many modern naturalists, who would be offended if we made this recommendation to them personally. Starting from a very ingenious comparison between the animal world and a bag of coins, Professor Newton indicates the general principles by which

we may recognize the agreements and differences of the various forms; he then points out the general purposes of classification and the principles of nomenclature, the principles of comparative anatomy and their application to the study of extinct animals, and the general facts of geographical distribution. His third chapter is devoted to a brief sketch of the classification of animals, the fourth to their development and reproduction, and the fifth to certain general observations on the food and instincts of certain species, mimicry, &c. In this chapter also the author discusses the question of the nature and possible origin of species. We most heartily recommend this little volume as a first book of zoology.

Mr. Wilson's work, which carries the teaching much further, and is really a student's manual, is also an excellent work of its kind. Mr. Wilson covers pretty nearly the same ground as Prof. Newton, although of course he enters into much more detail; and we have to compliment both authors on the same characteristic of their work—namely, the total freedom from prejudice with which they have discussed those unsettled questions which at present divide naturalists.

## PROCEEDINGS OF LEARNED SOCIETIES.

### ROYAL SOCIETY.

February 4, 1875.—Joseph Dalton Hooker, C.B., President, in the Chair.

“Remarks on Professor WYVILLE THOMSON'S Preliminary Notes on the Nature of the Sea-bottom procured by the Soundings of H.M.S. ‘Challenger.’” By WILLIAM B. CARPENTER, M.D., LL.D., F.R.S.

The extreme interest of two of the questions started and partly discussed in Professor Wyville Thomson's communication will be deemed, I trust, a sufficient reason for my offering such contributions as my own experience furnishes towards their solution.

The first of these questions is, whether the *Globigerina*, by the accumulation of whose shells the *Globigerina*-ooze is being formed on the deep-sea bottom, live and multiply on that bottom, or pass their whole lives in the superjacent water (especially in its upper stratum), only subsiding to the bottom when dead.

Having previously held the former opinion, Prof. Wyville Thomson states that he has now been led to adopt the latter, by the results of Mr. Murray's explorations of the surface and sub-surface waters with the tow-net—which results concur with the previous observations of Müller, Hæckel, Major Owen, and others, in showing that *Globigerina*, in common with many other Foraminifera, have a pelagic habitat; while the close relation which they further indicate between the surface-fauna of any particular locality and the materials of the organic deposit at the bottom, appears to Prof. Wyville Thomson to warrant the conclusion that the latter is altogether derived from the former.



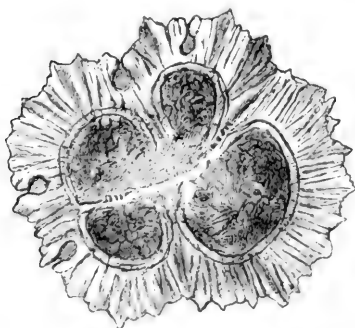
Now without in the least degree calling in question the correctness of these observations, I venture to submit, *first*, that they bear a different interpretation, and, *second*, that this interpretation is required by other facts, of which no account seems to have been taken by Prof. Wyville Thomson and his coadjutor. In this, as in many other instances, I believe it will prove that the truth lies between two extreme views. That the *Globigerinæ* live on the bottom only is a position clearly no longer tenable; but that they live and multiply in the upper waters only, and only sink to the bottom after death, seems to me a position no more tenable than the preceding: and I shall now adduce the evidence which appears to me at present to justify the conclusion (I refrain from expressing myself more positively, because I consider the question still open to investigation), that whilst the *Globigerinæ* are pelagic in an earlier stage of their lives, frequenting the upper stratum of the ocean, they sink to the bottom whilst still living, in consequence of the increasing thickness of their calcareous shells, and not only continue to live on the sea-bed, but probably multiply there—perhaps there exclusively.

That there is no *à priori* improbability in their doing so, is proved by the abundant evidence in my possession of the existence of Foraminiferal life at abyssal depths. The collections made during the 'Porcupine' Expeditions of 1869 and 1870 yielded a large number of those *Arenaceous* types which construct their "tests" by the cementation of sand-grains only to be obtained on the bottom; and these were almost the only Foraminifera, except *Globigerinæ* and *Orbulinæ*, which came up in the 2435-fathoms dredging. Again, many Foraminifera, both arenaceous and shelly, were brought up from great depths, attached to shells, stones, &c., that must have lain at the bottom. Further, among the "vitreous" Foraminifera, the most common deep-sea types, except those of the *Globigerine* family, were *Cristellarians* with shells so thick and massive as to be (it may be safely affirmed) incapable of being floated by the animals which form them; while among the "porcellaneous" Foraminifera, the *Biloculinæ* and *Triloculinæ* were equally distinguished by a massiveness of shell, which seemed to forbid the idea that they could have floated subsequently to that stage of their lives in which this massiveness had been acquired.

Of the existence of living *Globigerinæ* in great numbers in the stratum of water immediately above the bottom, at from 500 to 750 fathoms depth, I am able to speak with great positiveness. It several times happened, during the Third Cruise of the 'Porcupine' in 1869, that the water brought up by the water-bottle from immediately above the *Globigerina*-ooze was quite turbid; and this turbidity was found (by filtration) to depend, not upon the suspension of amorphous particles diffused through the water, but upon the presence of multitudes of young *Globigerinæ*, which were retained upon the filter, the water passing through it quite clear. The *thin shells* of these specimens, exhibiting very distinct

pseudopodial orifices, contrasted strongly with the larger and thicker shells of the specimens brought up by the sounding-apparatus from the bottom immediately beneath, in which the shells were thick and those orifices obscure. It is obvious that if this extraordinary abundance of Globigerine life in the bottom-water was the result of subsidence from the surface or sub-surface stratum, and was merely preparatory to the deposition of the shells on the sea-bed, there should have been a correspondence in size and condition between the floating shells and those lying on the bottom immediately beneath them; whereas no contrast could be more complete, the impression given by the superficial aspects they respectively presented having been fully confirmed by subsequent careful investigation.

Prof. Wyville Thomson and Mr. Murray, who notice this contrast, attribute it to the *death* of the shells which have subsided to the bottom—being apparently unaware that the observations of Dr. Wallich, with which my own are in entire accordance, leave no reasonable ground for doubt that it is a consequence of their continued *life*. For it is clearly shown, by making thin transparent sections of the thick-shelled *Globigerinæ* (an operation which needs a dexterity only to be acquired by long practice, and which is much facilitated by an ingenious device invented by Dr. Wallich\*), that the change of external aspect is due to the remarkable *exogenous deposit* (a rudiment of the “intermediate skeleton” of higher Foraminifera) which is formed, after the full growth of the *Globigerina* has been attained, upon the outside of the proper chamber-wall—so completely masking its pseudopodial orifices, that Prof. Huxley at one time denied their existence. This deposit is not only many times thicker than the original chamber-wall, but it often contains flask-shaped cavities opening from the exterior, and containing sarcode prolonged into it from the sarcodic investment of the shell. Illustrations of this curious structure are given by Dr. Wallich in figs. 17 and 18 of plate vi. of his ‘North-Atlantic Sea-bed;’ and I here subjoin a representation of it,



Section of Shell of *Globigerina*, showing the distinction between the original proper wall of the chambers and the secondary exogenous deposit, with the flask-shaped cavities in the latter opening externally and containing sarcode like that which fills the chambers.

kindly given me by Dr. Wallich twelve years ago, which further

\* *Ann. & Mag. of Natural History*, 1861, viii. p. 58.

shows that the specimen from which it was taken had both its chambers and the flask-shaped cavities of the exogenous deposit filled with sarcode not distinguishable in any respect from that of the floating specimens. From these important observations (which had not been made public when the sheet of my 'Introduction to the Study of the Foraminifera' comprising the Globigerine family passed through the press, but which I have myself subsequently confirmed in every particular) it seems an almost inevitable inference that the subsidence of the *Globigerinæ* to the bottom is the consequence, not of their death, but of the increasing thickness and weight of their shells, produced by living action. As long as the number of segments continues to increase, the carbonate of lime separated by the sarcodic body from the circumambient water goes to form the walls of additional chambers; but when this chamber-formation ceases (which usually occurs when the shell consists of either 12 or 16 segments), it is applied to thicken the walls of the chambers already formed; and from the rapid subsidence of the *Globigerinæ* taken up from the sea-bottom when thrown into a jar of sea-water, it seems to me inconceivable that they can be floated by their animal inhabitants when once the exogenous deposit has attained any considerable thickness.

That the *Globigerinæ* which have subsided to the bottom continue to live there, is further indicated by the condition of the sarcodic contents of their shells. In any sample of *Globigerina*-ooze that I have seen brought up by the dredge or the sounding-apparatus, part of the shells (presumably those of the surface-layer) were filled with a sarcode body corresponding in condition with that of Foraminifera known to live on the sea-bed, and retaining the characteristic form of the organism after the removal of the shell by dilute acid. As Dr. Wallich pointed out ('North-Atlantic Sea-bed,' p. 139), the sarcode of these is viscid, and inclined to coalesce again when crushed; the shell has a vivid but light burnt-sienna colour; and sarcodic bosses, like retracted pseudopodia, are distinguishable upon its exterior. The only misgiving I ever had in regard to the living condition of the *Globigerinæ* presenting these characters, was caused by the absence of any pseudopodial extensions; and this source of doubt has been now removed by the statement of Prof. Wyville Thomson, that no pseudopodia have ever been observed by Mr. Murray to be put forth by the *Globigerinæ* captured in surface-waters.—In the same sample will be found shells distinguishable from the preceding by their dingy look and greyish colour, by the want of consistence and viscosity in their sarcode contents, and by the absence of any external sarcodic investment; these are presumably dead. Other shells, again, are entirely empty; and even when the surface-stratum is formed of perfect *Globigerinæ*, the character of the deposit soon changes as it is traced downwards. "The sediment," as was correctly stated by Prof. Wyville Thomson, "gradually becomes more compact; and a slight grey colour (due, probably, to the decomposing organic matter) becomes more pro-

nounced, while perfect shells of *Globigerina* almost disappear, fragments become smaller, and calcareous mud, structureless and in a fine state of division, is in greatly preponderating proportion" ('Depths of the Sea,' p. 410). These facts seem to me to mark very strongly the distinction between the *living* surface-layer and the *dead* sub-surface layer, and to show that there is nothing in the condition of the Deep Sea that is likely to prevent or even to retard the decomposition of the dead sarcode bodies of *Globigerina*. We know that oxygen is present in Oceanic water, even to its abyssal depths, in sufficient proportion for the maintenance of animal life; and what suffices for this, must be adequate to promote the decomposition of organic matter. There is, moreover, a significant indication of the undecomposed condition of the sarcode bodies of the *Globigerina* of the surface-layer, in the fact that they serve as food to various higher animals which live on the same bottom. This was first pointed out by Dr. Wallich, who found that the contents of the stomachs of the *Ophiocoma* brought up in his 1260-fathoms sounding consisted of a number of fresh-looking *Globigerina* more or less broken up, minute yellow amorphous particles, and a few oil-globules ('North-Atlantic Sea-bed,' p. 145). And I have subsequently verified his statement in many other cases\*.

It seems to me clear, from the foregoing facts, that the *onus probandi* rests on those who maintain that the *Globigerina* do *not* live on the bottom; and such proof is altogether wanting. The most cogent evidence in favour of that proposition would be furnished by the capture, floating in the upper waters, of the large thick-shelled specimens which are at present only known as having been brought up from the sea-bed. And the capture of such specimens would only prove that even in this condition the *Globigerina* can float; it would not show that they cannot also live on the bottom.

That the *Globigerina* not only *live*, but *propagate*, on the Sea-bottom, is indicated by the presence (as already stated) of enormous multitudes of very young specimens in the water immediately overlying it. And thus all we at present know of the life-history of this most important type seems to lead to the conclusion, that whilst in the earlier stages of their existence they are inhabitants of the upper waters, they sink to the bottom on reaching adult age, in consequence of the increasing thickness of their shells, that they propagate there (whether by gemmation or sexual generation is not known), and that the young, rising to the surface, repeat the same history.

I now proceed to show that the relation between the surface-fauna and the bottom-deposit is by no means so constant as Prof. Wylie Thomson and Mr. Murray affirm it to be.

\* Thus Man indirectly draws sustenance from the *Globigerina*; for the Cod which he fishes on the Faroe Banks chiefly live on the *Ophiocoma* which swarm there, these again on the *Globigerina*, whilst the *Globigerina* seem to draw their sustenance from the organic matter universally diffused through sea-water, making it a *very* dilute broth!

It may be taken as proved that there is no want of Foraminiferal life in the Mediterranean. Prof. W. C. Williamson long ago pointed out that the "white mud" of the Levant is mainly a Foraminiferal deposit; I found a similar mud covering the bottom along the Tripoli coast; Mr. J. Gwyn Jeffreys has dredged Foraminifera in abundance in the Bay of Spezzia, Captain Spratt in the *Ægean*, Oscar Schmidt in the Adriatic, and I myself at various points in the Western basin along the northern coast of Africa. That Foraminifera, especially *Globigerinae*, abound in its surface-water at Messina, is testified by Hæckel in the passage cited by Prof. Wyville Thomson; and when it is considered how large an influx of Atlantic water is constantly entering through the Straits of Gibraltar, and is being diffused throughout the Mediterranean basin, and how favourable is its temperature-condition, it can scarcely be doubted that, if the doctrine now upheld by Prof. Wyville Thomson were correct, the deposit of *Globigerina*-shells over the whole bottom-area ought to be as abundant as it is in the Atlantic under corresponding latitudes. Yet I found the deeper bottoms, from 300 fathoms downwards, entirely destitute of *Globigerina* as of higher forms of animal life; and this was not my own experience only, but was also that of Oscar Schmidt, who made a similar exploration of the Adriatic. In my first visit to the Mediterranean, in the 'Porcupine' (1870), many hundredweight of the fine mud brought up by the dredge from great depths in the Western basin were laboriously sifted, and the siftings carefully examined, without bringing to light more than a stray drift-shell here and there. And in my second visit, in the 'Shearwater' (1871), I examined all the samples of bottom brought up by the sounding-apparatus from great depths in the Eastern basin, with the same result—giving all the more care to this examination, because Capt. Nares (probably through not having kept separate in his mind the results of the deeper and of the shallower soundings which he had previously made in the Mediterranean) assured me that I *should* find minute shells imbedded in the mud.

I can see no other way of accounting for the absence of *Globigerina*-ooze from the bottom of the Mediterranean, save on its shallow borders, than by attributing it to the unfavourable nature of the influences affecting the *bottom-life* of this basin—that is to say, the gradual settling-down of the fine sedimentary deposit which forms the layer of inorganic mud everywhere spread over its deeper bottom, and the deficiency of oxygen and excess of carbonic acid which I have shown to prevail in its abyssal waters giving them the character of a stagnant pool—these influences acting either singly or in combination.

Another fact of which Prof. Wyville Thomson is fully cognizant, and to which he formerly attached considerable importance as indicative of the *bottom-life* of the *Globigerinae*, is unnoticed in his recent communication: I refer to the singular limitation of the *Globigerina*-ooze to the "warm area" of the sea-bed between

the North of Scotland and the Faroe Islands. It will be recollected by those who have read my 'Lightning' and 'Porcupine' Reports on the exploration of this region, that whilst the whole upper stratum, from the surface to a depth of from 100 to 150 fathoms, has the temperature of the warm flow coming up from the S.W., and whilst this temperature falls so gradually in the "warm area" with increase of depth as to be still as high as 43° Fahr. at a depth of 600 fathoms, it falls so suddenly in the "cold area" between 150 and 300 fathoms, that the whole of its deeper stratum has a temperature below 32°, the bottom temperature descending in some parts to 29°.5. Now on this "cold area" I never found a single *Globigerina*, the bottom consisting of sand and gravel, and the Foraminifera brought up from it being almost exclusively those which form arenaceous tests. The "warm area," on the other hand, is covered with *Globigerina*-ooze to an unknown depth, its surface-stratum being composed of perfect shells filled with sarcode, whilst its deeper layers are amorphous. Near the junction of the two areas, but still within the thermal limit of the "warm," sand and *Globigerina*-ooze are mingled—this being peculiarly noticeable on the "*Holtenia*-ground," which yielded a large proportion of our most noteworthy captures in this locality. Now, if the bottom-deposit is dependent on the life of the surface-stratum, why should there be this complete absence of *Globigerina*-ooze over the "cold area," the condition of the surface-stratum being everywhere the same? I was myself formerly disposed to attribute it to the depression of bottom-temperature; but as it has now been proved by the 'Challenger' observations in the Atlantic that *Globigerina*-ooze prevails over areas whose bottom-temperature is but little above 32°, this explanation can no longer be accepted. And I can see no other way of accounting for it than by attributing it to the drift of the cold underflow, carrying away the *Globigerinae* that are subsiding through it towards the deep basin of the Atlantic, into which I believe that underflow to discharge itself. Prof. Wyville Thomson, however, denies any sensible movement to this underflow, continuing to speak of it as "banked up" by the Gulf-stream\*, which here (according to him) has a depth of 700 fathoms; and this very striking example of want of conformity between the surface-fauna and the bottom-deposit consequently remains to be accounted for on his hypothesis.

The other of Prof. Wyville Thomson's principal conclusions, as to which I have rather a suggestion to offer than an objection to take, relates to the origin of the "red clay" which he found

\* See his 'Depths of the Sea,' p. 400. That there is a lateral pressure of the one flow against the other, just as there is a lateral pressure of the Labrador Current against the Gulf-stream on the North-American coast (producing the well-known "cold wall"), is sufficiently obvious from their relative distribution on the bottom of the channel. But it seems to me perfectly clear that the effect of this pressure is simply to narrow the glacial flow, and at the same time to increase its velocity. The most westerly point to which we traced it was near the edge of the Faroe Banks; and there (as Prof. Wyville Thomson himself pointed out to me at the time) the movement of the bottom-water was

covering large areas in the Atlantic, and met with also between Kerguelen's Island and Melbourne. Into this red clay he describes the *Globigerina*-ooze as graduating through the "grey ooze;" and he affirms this transition to be essentially dependent on the depth of the bottom. "Crossing," he says, "from these shallower regions occupied by the ooze into deeper soundings, we find *universally* that the calcareous formation gradually passes into, and is replaced by, an extremely pure clay, which occupies, speaking generally, all depths below 2500 fathoms, and consists almost entirely of a silicate of the red oxide of iron and alumina. . . . . The mean maximum depth at which the *Globigerina*-ooze occurs may be taken at about 2250 fathoms; the mean depth at which we find the transition grey ooze is 2400 fathoms; and the mean depth of the red-clay soundings is about 2700 fathoms. . . . . We were at length able," he continues, "*to predict the nature of the bottom from the depth of the soundings with absolute certainty* for the Atlantic and the Southern Sea." And from these data he considers it an indubitable inference "that the red clay is essentially the insoluble residue, the *ash*, as it were, of the calcareous organisms which form the *Globigerina*-ooze after the calcareous matter has been by some means removed." This inference he considers to have been confirmed by the analysis of several samples of *Globigerina*-ooze, "always with the result that a small proportion of a red sediment remains, which possesses all the characters of the red clay." Prof. Wyville Thomson further suggests that the removal of the calcareous matter may be due to the presence of an excess of carbonic acid in the bottom-waters, and to the derivation of this water in great part from circumpolar freshwater ice, so that, being comparatively free from carbonate of lime, its solvent power for that substance is greater than that of the superjacent waters of the ocean. He might have added probability to his hypothesis if he had cited the observations of Mr. Sorby as to the increase of solvent power for carbonate of lime possessed by water under greatly augmented pressure\*.

Greatly struck with the ingenuity of this hypothesis, I turned to Prof. Wyville Thomson's tabular statement of the facts in detail, and must own to a great feeling of surprise at the want of conformity of these details with the assertions of universality and certainty of prediction which I have italicized in the above extracts.

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evidenced by the rounding into pebbles of what was elsewhere angular gravel. But it is even more conclusively shown by a comparison of the two serial soundings taken in the "cold area" (Nos. 52 and 64), which proves that the glacial stratum *flows up a slope* in the former position (just as the cold understratum does in the Florida Channel), which it could not do unless it were in movement. That we did not trace the outflow of this cold stream into the great basin of the Atlantic, was simply, as I believe, because we were prevented from ascertaining the bottom-temperature on the line which I expected that flow to take after surmounting the ridge.

\* Proceedings of the Royal Society, vol. xii. p. 538.

Thus in the deepest sounding in the whole Atlantic (that of 3875 fathoms, taken on the voyage from St. Thomas to Bermuda), as well as in the next two soundings of 2960 and 2800 fathoms respectively (the average of the three being 3211 fathoms), the bottom was "grey ooze;" whilst in the next three soundings of 2850, 2700, and 2600 fathoms respectively (the average of the three being 2716 fathoms, or nearly 400 fathoms less than the preceding) the bottom was of "red clay." Between Bermuda and the Azores, again, there were six successive soundings between 2700 and 2875 fathoms, in which the bottom was "grey ooze."

It is clear, then, that no constant relation exists between depth and the nature of the bottom. If not only eight ordinary soundings whose average was almost exactly 2800 fathoms, but the extraordinarily deep sounding of 3875 fathoms, gave a bottom of "grey ooze," it surely cannot be "an ascertained fact that wherever the depth increases from about 2200 to 2600 fathoms, the modern chalk formation of the Atlantic and other oceans passes into a clay."

Now, if this "red clay" had the character of an ordinary river-silt, it would be quite conformable to my Mediterranean experience to regard it (as Prof. Wyville Thomson himself was at first disposed to do) in the light of a derivative from the land, diffused through the ocean-water and slowly settling down over particular areas, to which it might be determined by the prevalent direction of the bottom-flow, which would greatly depend in its turn upon the ridge-and-valley conformation of the sea-bed. And the presence of a small proportion of this material in the ordinary *Globigerina*-ooze, whilst, where it is deposited in quantity, there are neither entire *Globigerinae* nor their disintegrated remains, would be perfectly consistent with the known destructive effect of the slow subsidence of a muddy sediment on many forms of animal life\*.

But I agree with Prof. Wyville Thomson in thinking that the remarkable uniformity of this deposit, coupled with its peculiar composition, indicates a different derivation; and the suggestion I have to offer is based on its near relation in composition, notwithstanding its great difference in appearance, to *Glauconite*—the mineral of which the green sands that occur in various geological formations are for the most part composed, and which is a silicate of peroxide of iron and alumina.

It is well known that Prof. Ehrenberg, in 1853†, drew attention to the fact that the grains of these green sands are for the most part, if not entirely, *internal casts* of Foraminifera—the sarcodic bodies of the animals having been replaced by glauconite, and the calcareous shells subsequently got rid of, either by abrasion or by some solvent which does not attack their contents. It was soon afterwards shown by Prof. Bailey (U. S.) that in certain localities

\* See my 'Shearwater' Report in Proceed. Roy. Soc. 1872, vol. xx. p. 584.

† "Ueber den Grünsand und seine Erläuterung, etc.," in Abhandl. der königl. Akad. der Wissensch. zu Berlin, 1855, p. 85.



a like replacement is going on at the present time, the chambers of recent Foraminifera being occasionally found to be occupied by mineral deposit, which, when the shell has been dissolved away by dilute acid, presents a perfect internal cast of its cavities. By the application of this method to Mr. Beete Jukes's Australian dredgings, my coadjutors, Messrs. W. K. Parker and T. Rupert Jones, obtained a series of internal casts of most wonderful beauty and completeness, on which I have based my interpretation of the organic structure of *Eozoon canadense*. Having myself examined in the same manner a portion of the Foraminiferal sand dredged by Capt. Spratt in the Ægean (kindly placed in my hands by Mr. J. Gwyn Jeffreys), I have found that it yielded a great variety of these beautiful models, not only of the bodies of Foraminifera, but also of the sarcodic network which interpenetrates the calcareous network of the shell and spines of Echinida\*.

Alike in Mr. Jukes's and in Capt. Spratt's dredgings, some of these casts are in *green* silicates and some in *ochreous*, corresponding precisely to the two kinds of fossil casts described by Prof. Ehrenberg. The difference I presume to depend upon the degree of oxidation of the iron; but as these casts are far too precious to be sacrificed for chemical analysis, I cannot speak with certainty on this point.

As it is only in certain limited areas of the sea-bottom that this replacement of the sarcodic bodies of Foraminifera by mineral deposit is met with, it has always seemed to me next to certain that there must be some peculiarity in the composition of the seawater of those areas (produced, perhaps, by the outburst of submarine springs highly charged with ferruginous silicates) which gives to them a capability that does not exert itself elsewhere; and this now seems yet more probable from the circumstance that, notwithstanding the vast extent over which the 'Challenger' soundings and dredgings have been prosecuted, only two or three cases of the kind have been noted—those, namely, of the "greenish sands" brought up from 98 and 150 fathoms in the region of the Agulhas Current and in one or two other localities. It is a fact of peculiar interest, moreover, that the calcareous shells should have here disappeared, just as they have done in ordinary green-sand—and this, too, although the depth was so small as altogether to forbid the idea that their disappearance is due to any solvent process brought about by the agencies to which Prof. Wyville Thomson attributes the removal of the calcareous deposit generated by Globigerine life.

Now, in the residue left after the decalcification of Capt. Spratt's dredgings, I noticed a number of small particles of *red clay*, some of them presenting no definite shape, whilst others approximated sufficiently closely in form and size to the green and ochreous

\* Of these I hope to be able, ere long, to give a detailed account, in illustration of the similar models of the animal of *Eozoon* obtained by the decalcification of its serpentine lamellæ.

“internal casts” to induce me to surmise that these also had been originally deposited in the chambers of Foraminifera—their material being probably very nearly the same, although its state of aggregation is different. And if this was their real origin, I should be disposed to extend the same view to the red clay of the ‘Challenger’ soundings; for a strong *à priori* improbability in the supposition that this is the “ash” of the shells themselves is created by the fact that we have no knowledge (so far as I am aware) of the presence of any such ash in calcareous organisms of similar grade. It is certainly not proved by the analyses of *Globigerina*-ooze quoted by Prof. Wyville Thomson, since this (supposing it to be free from any extraneous admixture) may have contained many shells partially or completely filled with such deposit. The only analysis that could prove it would be either that of shells of floating *Globigerina*, which may be presumed to be alive, or of those found in the surface-layer of the *Globigerina*-ooze, which (whether living or dead) have their chambers filled with sarcode.

I submit, then, that if the red clay is (as I am disposed to believe) a derivative of the *Globigerina*-ooze, its production is more probably due to a *post mortem* deposit in the chambers of the Foraminifera than to the appropriation of its material by the living animals in the formation of their shells. That deposit may have had the character, in the first instance, of either the green or the ochreous silicate of alumina and iron, which constitutes the material of the internal casts, and may have been subsequently changed in its character by a metamorphic action analogous to that which changes felspar into clay. That the presence of an excess of carbonic acid would have an important share in such a metamorphosis appears from the fact, long since brought into notice by Sir Charles Lyell\*, of the disintegration of the granite in Auvergne and of the gneiss in the alluvial plains of the Po where subject to its influence. And the same agency (especially when operating under great pressure) would be fully competent to effect the removal of the calcareous shells, as was distinctly pointed out nearly thirty years ago by Prof. W. C. Williamson in his classical memoir on the Microscopic Organisms of the Levant Mud†. This seems to me the most probable mode of accounting for their disappearance from a deep-sea deposit, where no mechanical cause can be invoked. But in shallower waters, where the same excess of carbonic acid does not exist, and the aid of pressure is wanting, but where a movement of water over the bottom is produced by tides and currents, I am disposed rather to attribute the disappearance of the shells to mechanical abrasion, having noticed, in Capt. Spratt’s Ægean dredgings, that many of the shells were worn so thin that the coloured mineral deposit in their interior could be seen through them—which was, in fact, what first drew my attention to its presence. This is the explanation I should be disposed

\* Principles of Geology, 11th ed., vol. i. p. 409.

† Memoirs of the Literary and Philosophical Society of Manchester, vol. viii. p. 98.

to give of the disappearance of the shells from the green sand brought up by the 'Challenger' in the course of the Agulhas Current; but whether it was mechanical abrasion or chemical solution that removed the Foraminiferal shells whose internal casts formed the Greensand deposit of the Cretaceous epoch, must remain for the present an open question\*.

February 11, 1875.—Joseph Dalton Hooker, C.B., President, in the Chair.

“On the Structure and Development of *Myriothela*.”

By Prof. ALMAN, F.R.S.

The *endoderm* of the body is composed of numerous layers of large spherical cells composed of clear protoplasm, enclosing a nucleus with some brown granules and refringent corpuscles. Externally it is continued in an altered form into the tentacles, while internally it forms long thick villus-like processes which project into the cavity of the body. Towards the free ends of these processes there are abundantly developed among the large clearer cells, smaller, easily isolated spherical cells, filled with opaque brown granules. Where the endoderm passes into the tentacles it loses its large clear-celled condition, and consists of small round cells, so loaded with opaque granules that the axis of the tentacle appears nearly white under reflected light.

The free surface of the endoderm carries, at intervals, long, very slender, sluggishly vibrating cilia, and is overlaid with a thin layer of homogeneous protoplasm, which on the villus-like processes becomes especially distinct, and which here develops minute mutable pseudopodia, which are being constantly projected and withdrawn. Indeed the vibratile cilia appear to be but a modification of these pseudopodial processes of protoplasm.

Interposed between the endoderm and the ectoderm is the *fibrillated layer*. It is extremely well developed, and consists of longitudinal muscular fibrillæ, closely adherent to the outer surface of a structureless hyaline membrane—the “Stützlamelle” of Reichert. The fibrillated layer, with its supporting membrane, is so strong as to remain entire in a section of the animal after the tissues on both sides of it have been broken down.

The *ectoderm* is composed of two zones, a superficial and a deep. The superficial zone consists mainly of two or three layers of small round cells containing yellowish granules. Among these cells the thread-cells may be seen, lying chiefly near the outer surface of the body. Two forms of thread-cells may be here di-

\* It is due to Prof. W. C. Williamson to point out that, in the Memoir already referred to, he indicated the probability “that many of our European Greensands, and other siliceous strata, however barren of such structures they appear, may have once contained multitudes of calcareous microscopic organisms, some of which have been removed *after* the consolidation of the strata, either leaving hollow casts, or having had the cavities subsequently filled with silica.”

stinguished—one ovate, with the invaginated tube occupying the axis; the other fusiform, with the invaginated tube oblique.

The deeper zone of the ectoderm consists of a very remarkable tissue, composed of peculiar membraneless cells, each of which is prolonged into a tail-like process, so that the cells assume a claviform shape. In most situations, where this tissue is developed, the processes from several such cells unite with one another, so as to form branching, somewhat botrylliform groups, whose common stalk can be followed into the fibrillated layer. The author is thus enabled so far to confirm the observations of Kleinenberg on cells of apparently the same significance in *Hydra*. In *Myriothele*, however, these cells do not, as in *Hydra*, reach the surface. With the exception, apparently, of their condition in the transitory arms of the *Actinula* or locomotive embryo, they form everywhere a deep zone interposed between the muscular layer and the superficial layer of the ectoderm. This zone is designated by the author as the zone of *claviform tissue*. Though it is in intimate association with the fibrillated layer, the author did not succeed in tracing a direct continuity of the individual fibrillæ with the processes of the cells (as described by Kleinenberg in *Hydra*).

The author adopts, as a probable hypothesis, the views of Kleinenberg respecting the caudate cells of *Hydra*, which he regards as representing a nervous system. While the deep layer of ectodermal cells in *Myriothele* would thus constitute a nervous layer, the superficial layer would represent an epidermis; and since recent researches justify us in regarding the ectoderm and endoderm of the Cœlenterata as respectively representing in a permanent condition the upper and lower leaf of the blastoderm in the development of the higher animals, we should thus find *Myriothele* offering no exception to the general law, which derives both epidermic and nervous tissues from the upper leaf of the blastoderm.

The structure of the tentacles is in the highest degree interesting. In their narrow stalk-like portion, the condition of the endoderm departs widely from that of this tissue in the tentacles of other marine hydroids; for it presents no trace of the septate disposition so well marked in these. It is, on the contrary, composed of a layer of small cells loaded with opaque granules and surrounding a continuous wide axile cavity.

It is, however, in the terminal capitulum of the tentacle that the structure of these organs departs most widely from any thing that has as yet been recognized in the tentacles of other hydroids. Here a very peculiar tissue is developed between the muscular layer and the proper ectoderm, where it takes the place of the zone of claviform tissue. It forms a thick hemispherical cap over the muscular lamella and endoderm of the tentacle, and is composed of closely applied exceedingly slender prisms, with their inner ends resting on the muscular lamella, to which the prisms are perpendicular, the whole structure forcibly suggesting the rod-like tissue associated with special sense-apparatus in higher animals. It

appears to be but a modification of the tissue which elsewhere forms the zone of claviform tissue.

Extending in a radiating direction from the convex surface of this rod-like tissue, towards the external surface of the tentacle, may be seen numerous firm filaments, each of which, making its way among cells of the ectoderm, terminates distally in a very delicate transparent oviform sac, which carries, near its distal end, a minute styliiform process. Within this sac, and completely filling it, is an oviform capsule with firm transparent walls, and having immersed in its clear refringent contents a cylindrical cord wound upon itself in two or three coils. Under pressure, the contained cord may be sometimes forced out through the smaller or distal end of the capsule. Notwithstanding the obvious resemblance of these bodies to thread-cells, their significance is, without doubt, something entirely different. Indeed their resemblance to the Pacinian bodies of Vertebrata is too strong to be overlooked. Their assemblage constitutes a zone parallel to the spherical surface of the capitulum, and lying at a slight distance within it. Though it is impossible to assign to them, with certainty, their exact function, we feel compelled to regard the whole system, including the bacillar tissue to which their stalks can be traced (and which is only a locally modified portion of the nervous zone, or zone of claviform tissue), as an apparatus of sense. It would almost seem to represent a form of sense-organ, in which sight and touch show themselves in one of their earliest phylogenetic stages, in which they have not yet become fully differentiated from one another. This is the only known instance of the existence in a hydroid trophosome of any thing which may with fair reason be regarded as a special apparatus of sense.

The male and female sporosacs are borne by the same trophosome.

The generative elements, whether male or female, originate in a special cavity (gonogenetic chamber), which is formed in the substance of the endoderm of the sporosac.

In the female, the primitive plasma becomes gradually differentiated into a multitude of cell-like bodies having all the characters of true ova with their germinal vesicle and spot. They are entirely destitute of enveloping membrane.

These bodies next begin to coalesce with one another into numerous roundish masses of protoplasm, which develop over their surface minute pseudopodial retractile processes.

The masses thus formed still further coalesce with one another; and there results a single spheroidal plasma-mass, through which are dispersed numerous small spherical vesicles, mostly provided with a nucleus. These vesicles appear to be nothing more than the nucleolated nuclei of the coalesced ovum-like cells.

About the time of the completion of this last coalescence, the resulting plasma-mass, enveloped in an external, very delicate, structureless membrane, is expelled, by the contraction of the sporosac, through an aperture formed by rupture in its summit.

Immediately after its expulsion, it is seized, in a manner which forcibly suggests the supposed action of the Fallopian tube on the mammalian ovum at the moment of its escape from the Graafian follicle, by the sucker-like extremities of certain remarkable bodies, to which the author gives the name of *claspers*, which are developed among the blastostyles, and resemble long filiform and very contractile tentacles.

It is apparently now that fecundation is effected; for the plasma becomes again resolved into a multitude of roundish masses. This phenomenon may be regarded as representing the yelk-cleavage of an ordinary ovum. Reasons are assigned for believing that it is through the agency of the claspers that fecundation takes place; and the claspers are compared to the hectocotylus of Cephalopods, and to certain organs by which fecundation is effected among the Algae.

The mulberry-like mass thus formed, surrounded by its structureless membrane, which has now acquired considerable thickness and forms a firm capsule, continues to be held in the grasp of the claspers during certain subsequent stages of its development. An endoderm and ectoderm with a true multicellular structure become differentiated, a central cavity is formed by excavation, and the germ becomes thus converted into a spheroidal non-ciliated *Planula*. This, after acquiring certain external appendages, ultimately escapes, by the rupture of the capsule, as a free actinuloid embryo.

The actinuloid, on its escape from its capsule, is provided not only with the long arms already noticed by Cocks and Alder, but with short scattered clavate tentacles. The short clavate tentacles become the permanent tentacles of the fully developed hydroid; the long arms, on the other hand, are purely embryonic and transitory.

The long embryonic arms originate in the spheroidal *Planula*. They are formed by a true invagination, and at first grow inwards into the body-cavity of the *Planula*. It is only just before the escape of the actinuloid from its capsule that they evaginate themselves and become external.

After enjoying its free existence for one or two days, during which it moves about by the aid of its long arms, the embryo fixes itself by its proximal end, the long arms gradually disappear, the short permanent tentacles increase in number, and the essential form of the adult is soon acquired.

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#### MISCELLANEOUS.

*On Pinaxia.* By EDGAR A. SMITH, F.Z.S., Zoological Department, British Museum.

THIS genus was formed by Mr. A. Adams (Proc. Zool. Soc. 1853, p. 185) for the reception of a little shell said to have been found at the Philippine Islands by Mr. Cuming, and described under the

name of *P. coronata* on the same page, and figured in the 'Genera of Recent Mollusca' by Messrs. H. and A. Adams on pl. xiv. fig. 1.

Mr. E. W. H. Holdsworth has recently presented to the British Museum a series of shells which he had collected in Ceylon; and among them are three specimens of *Pinaxia*, two of which have the operculum preserved. It is horny, stained with pinkish colour, and of the usual form that obtains among the *Purpurinæ*, and thus shows that this genus has been rightly located by the above authors. The small transverse plaits on the columella (about six in number) appear to exist only in the adult shell; and the same remark applies to the fine lirations within the aperture.

In a variety from the Sandwich Islands the coronation which edges the spire in the typical form is totally wanting, the general form is more bulbous, and the spiral lirations are but slightly raised. The deciduous epidermis is villose and of a pale olive colour.

In 1839, in the 'Zoology of Beechey's Voyage,' p. 114, Dr. Gray described a shell from the Pacific Ocean under the name of *Purula versicolor*. The description is excellent; but by an oversight or printer's error, the colour is stated to be '*bright crimson*,' which no doubt should have been *bright orange*. The specimen from which the description was taken, although a large one, is not adult; and consequently the character of the plaits on the columella is not mentioned. Taking these two circumstances into consideration, I think it will be advisable to adopt the more recent name *coronata*.

Perhaps this may be a fitting opportunity to acquaint conchologists that one of the last, and not least, of the innumerable acts of generosity of the late deeply lamented Dr. Gray was the presentation by him to the British Museum of his private collection of shells. How valuable an acquisition to the National Collection this is will at once be acknowledged, as it comprises a large number of types of his species which were described many years ago in the Zoology of 'Beechey's Voyage,' Griffith's edition of Cuvier's 'Animal Kingdom,' the 'Annals and Magazine of Natural History,' the 'Zoological Journal,' the 'Zoological Miscellany,' &c. A number of these species are but briefly characterized and unfigured; so that in the present state of conchological science it is almost impossible to recognize them, at least with any degree of certainty, except by comparison with the actual types. Thus the value of the collection becomes greatly enhanced.

*On the general Phenomena of the Embryogeny of the Nemertians.*

By M. J. BARROIS.

Amongst the numerous obstacles which one encounters at each step in researches in embryogeny, there is none more serious than that presented by the multiplicity of the larval forms in the same group of animals. These divergences, often very great in the first stages of development, prevent us from taking these as a starting-point in the appreciation of the subsequent phenomena: conse-

quently any deduction drawn from the mode of development becomes impossible, and embryogeny (that powerful aid to anatomy) seems to fail entirely.

It is therefore of the greatest importance to obtain a knowledge of the mutual relations which unite these different larval forms. It is thus that Fritz Müller has shown, by the embryogeny of *Peneus*, the bonds which unite the *Nauplius* and the *Zoëa*.

Of all the groups which present this mode of complication, the Nemertians certainly show one of the most remarkable cases. Side by side with the form *Pilidium*, which constitutes one of the most typical examples of geneagenesis, numerous larvæ occur, which, without any analogous phenomenon, pass directly to the adult state. On the one hand we have a transparent animal furnished with elegant extensions and ciliated bands, which the older observers very naturally compared to the well-known larvæ of the Echinoderms. From this first sketch originates, by internal budding, the future *Nemertes*, which, as soon as it is formed, quits its nurse to live an independent life. On the other hand, again, we see a small ciliated very simple larva issue from the egg, a simple oval body, differing but little in appearance from the egg which gave it birth (the larva of Desor), and which, without any other perceptible phenomenon except a mere differentiation of tissues, is gradually transformed into a complete *Nemertes*.

During a residence of several months last summer at the Zoological Laboratory of Wimereux, directed by Professor Giard, I was enabled to study this question in a connected manner; and it is the results of my researches on this subject that I have the honour of communicating to the Academy.

Together with a great number of unimportant forms of the larvæ of Desor, which reach their complete development gradually without presenting any abnormal phenomenon, I had the good fortune to meet with some forms of great interest, which, besides a great number of very instructive facts, have furnished me with the transition term between the two modes of development, so different in appearance, the *Pilidium* and the larva of Desor.

Among all the species which I have observed, the most remarkable is without question a species very common at Wimereux, and which I have been able to follow in a very detailed manner in all the phases of its evolution, namely *Nemertes communis* (Van Bened.). Although reproducing in its development all the essential peculiarities which characterize the *Pilidium*, this species presents a very marked approach towards the simpler states, and offers incontestable analogies to the larva of Desor.

I reserve for a more extended memoir the details relating to the very curious processes which give origin to the various systems of organs of the Nemertians; I only desire now to call attention to a main point, the passage from the *Pilidium* to the larva of Desor.

It is known, from the recent researches of Kowalevsky and Metschnikoff, that in the *Nemertes* with a *Pilidium* the spheres of segmentation of the egg arrange themselves very early radiately around a central cavity, which is at first very small; this latter



enlarges rapidly and drives all the cells towards the periphery, so as to constitute a superficial membrane. There is thus produced a closed vesicle, with the wall formed of a single series of cells (*blastosphere*). This vesicle becomes invaginated and gives origin to a double-walled sac (*Gastrula*); it is at this stage that hatching takes place. The *Gastrula* breaks through the vitelline membrane and begins to swim freely in the liquid. Then commences an interruption in the development, during which the larva, adapting itself to pelagic life, acquires all the different peculiarities characteristic of the *Pilidium*. It is only after this interruption, corresponding to the duration of independent life, that the development commences which is to lead to the formation of the *Nemertes*. There is here, evidently, an exaggeration of a larval state followed by a return to the type.

To form the *Nemertes* [from the *Pilidium*], four little invaginations take place at the expense of the exoderm; these detach themselves and produce four vesicles which fall into the cavity of the body of the *Pilidium*, where they become flattened and are transformed into hollow disks, formed of a thin external lamella turned towards the exoderm, and a thick internal lamella turned towards the endoderm. These four disks soon meet, surrounding the intestine, join together, and coalesce, and thus form a double membrane around the intestine: the inner membrane, formed by the junction of the inner lamellæ of the disks, will become the skin of the *Nemertes*; the outer one, formed by the coalescence of the external lamellæ, will constitute a provisional membrane, the amnios, which will disappear at the same time as the skin of the *Pilidium* to set the *Nemertes* at liberty.

Without being actually identical, the resemblance of the development of our *Nemertes* to that which we have just indicated is great enough to exclude all confusion between the two forms described. As before, the first stages of development are characterized by the presence of a blastosphere which becomes invaginated to give origin to a *Gastrula*. In the same way, the formation of the *Nemertes* is accomplished, in general, by means of the envelopment of the intestine by large discoidal lamellæ, which become confluent and unite by their edges to constitute the skin of the *Nemertes*. Finally, the primitive exoderm is destroyed, and the animal formed in its interior is set at liberty. But there the analogy stops. Our *Nemertes*, in fact, presents some important peculiarities which remove it from the *Pilidium* to bring it nearer the larva of Desor. We have, in the first place, the absence of pelagic life and of the interruption of the development which results from it. Here all the development is performed, from beginning to end, in the interior of the egg, and the animal which issues from it has already acquired the characteristic form of the *Nemertes*. Besides this fundamental fact, we see also that there is an evident simplification of the embryogeny and a gradual progress towards the extreme condensation which is observed in the larva of Desor. The stage which corresponds to the *Pilidium* has already lost all the different characteristic appendages which result from life in a free state, and is reduced to a simple *Gastrula* covered with fine vibratile cilia.

Lastly, we can prove the disappearance of one of the two embryonic membranes, the amnios. The disks which surround the digestive tube are not here composed of hollow sacs, but of solid lamellæ; so that a single membrane, the skin of the *Nemertes*, results from their union. In a word, we see manifested under our eyes a remarkable tendency to the suppression of the exaggeration of the larval state which constitutes the *Pilidium*, and to a return to the direct mode of development.

Here, then, we have, by the side of a development very like that of the *Pilidium*, a very great simplification and an evident condensation of the embryogeny. One step further and we arrive at the extreme condensation which is observed in the larvæ of Desor. We have therefore before us an intermediate stage between the *Pilidium* and the larva of Desor; and this result seems to be of incontestable importance. It enables us to correlate the two widely different forms of the embryos of the Nemertians, and shows us that the mutual relations which exist between them are analogous to those which Fritz Müller has informed us exist between the *Nauplius* and the *Zoëa*. Like the *Nauplius*, the *Pilidium* is the primitive form; and the larva of Desor represents a condensed form derived from the former by the abbreviation of the embryogeny.—*Comptes Rendus*, January 25, 1875, pp. 270–273.

*On the Reproductive Organs of the Eels.* By M. SYRSKI.

In 1872 two memoirs appeared almost simultaneously by Italian authors, who announced that they had discovered that the eels are hermaphrodites. The agreement in general results was certainly adapted to inspire some confidence; but, on the other hand, considerable divergences in the descriptions of the organs showed that the question was far from being completely cleared up. These differences might arise from errors of observation; or they might be ascribed to differences of organization due to the species, age, or sex of the fishes examined.

According to M. Syrski all that relates to the male organs in these two memoirs is completely erroneous, and the eels are not hermaphrodites at all; MM. Balsamo-Crivelli and Maggi were the subjects of an illusion when they thought they had ascertained the presence of spermatozoids; the organs regarded by them as the testes are nothing more than fatty bodies.

Notwithstanding the assertions of the preceding authors, and the gap which exists in the researches of M. Syrski, the probabilities seem to be entirely in favour of the unisexuality of the eels.

In these fishes the males are smaller than the females. Eighty-six individuals, 218–430 millims. in length, examined by M. Syrski proved to be males; and ninety others, 275–1050 millims. long, were females. The previous observers having preferred examining large individuals, had only females under their inspection.

The testes appear as nearly symmetrical paired organs, in the form of long ribbons, attached, like the ovaries, along the dorsal wall of the abdominal cavity. That of the right side commences a

little further forward, and terminates not quite so far back as that of the left side, as is also the case with the ovaries. Both have at their posterior part a sort of prolongation (*pars recurrens*), which turns forward. Their hyaline aspect and their dimensions give them a great resemblance to the incompletely developed ovaries; but with a little attention it is seen that they have not the same structure as the female organs, but form two simple longitudinal series of lobules of regular form. Of these lobules there are about 48-50 in each testis; they are compressed and shorter at their base than at their free margin, which is broadly rounded, so that they slightly cover each other. The ovaries are suspended from simple ribbons formed by the peritoneum, whilst each of the testes adheres to the walls of a longitudinal canal (the *deferent duct*). Each canal terminates caecally in front, and ends posteriorly in a triangular sac (*bursa seminalis*) applied against the lateral walls of the urinary bladder. The sac of one side is in communication with that of the other by a transverse fissure (*fissura recto-vesicalis*) which occurs between the rectum and the neck of the urinary bladder. This fissure also leads from the two sacs into a pit (*fovea recto-vesicalis*) which is continued into the genital pore. The genital pore itself does not open directly outwards, but into the urethra.

In the female there are neither canals nor sacs; but the genital pore also opens into the urethra.

The stroma of the testis is much more resistant than that of the ovary. Each lobe is formed of compartments about 0.05 millim. in diameter, filled with isolated nuclei, aggregations of nuclei, and cells.

The principal arguments which the author brings forward in favour of his new interpretation of the reproductive apparatus of the eels are as follows:—

1. The organs which he regards as testes occupy the same relative position as the ovaries, but differ from the latter in form and structure.

2. The ducts which are in close connexion with them, and open into the genital pore, cannot be any thing but the deferent ducts and the *vesiculæ seminales*.

3. The ducts, *vesiculæ*, and the genital pore open in proportion as the testes are developed—a course of things which is the same as that observed with regard to the female genital pore relatively to the development of the ovaries.

4. The lobate organs resemble, especially in structure, the testes of the fishes allied to the eels.

5. The eels which possess these organs are destitute of any other formation that could be regarded as a reproductive organ.

This collection of facts appears quite conclusive. It now only remains to discover the spermatozoids, which M. Syrski has not been able to find in the small eels. This gap in the evidence is of considerable importance; and it is to be hoped that it may soon be filled.—*Sitzungsber. der Akad. der wiss. in Wien, Math.-naturw. Classe*, Band lxix. April 1874; *Bibl. Univ.* February 15, 1875, p. 163.

*Revision of the Nematoids of the Gulf of Marseilles.*

By M. A. F. MARION.

The recent note by M. Villot on the peripheral nervous system of the Nematoids determines me to defer no longer some rectifications which I intended for a general memoir on the mode of distribution of the marine animals of the gulf of Marseilles. M. Villot indicates in the hypodermal layer of the oceanic Nematoids a remarkable nervous network identical with that which he has described in *Gordius*. This interesting publication greatly modifies the notions that we had as to the sensory apparatus of these little worms. It is only necessary to glance through Bastian's important memoirs (Phil. Trans. 1866, p. 565, and Trans. Linn. Soc. 1865, part 2, p. 83) in order to see how unsettled this question remained. I hope to resume this anatomical investigation upon the species of the Etang de Berre, and to profit by the statements of M. Villot. It is desirable to determine exactly the nature of that œsophageal ring that Bastian refers to the glandular system. The rectifications that I shall now present relate solely to the systematic arrangement of the species of the shores of Marseilles.

The groups that I formerly proposed correspond exactly with those established by Bastian. My genera *Amphistenus*, *Stenolaimus*, *Heterocephalus*, *Thoracostoma*, and *Enoplostoma* are synonymous with his genera *Symplocostoma*, *Anticoma*, *Phanoderma*, *Leptosomatum*, and *Enoplus*. It is difficult to compare the species with a transversely striated cuticle. I recognize in Bastian's figures various tegumentary adornments that I have observed on the Nematoids of Marseilles; but the buccal and penial armatures appear to differ completely, although their details are not always very distinctly represented. The genera *Lasiomitus*, *Eurystoma*, *Necticonema*, *Rhabdotoderma*, and *Acanthopharynx* may therefore be retained. I may add that *Symplocostoma longicollis*, Bast., is probably the same worm that I have called *Amphistenus agilis*, and which does not differ from the *Enoplus tenuicollis* of Eberth. In the same way *Heterocephalus laticollis*, Mar., is identical with *Phanoderma Cocksii*, Bast., the supplementary penial plate of which is not represented in the plates of the monograph of the Anguillulidæ.

To the same species I do not hesitate to refer the *Enoplus tuberculatus* of Eberth. Bastian gives new characters for the genus *Enoplus* of Dujardin, from which he excludes the freshwater worms. The group thus limited corresponds to my genus *Enoplostoma*. *Enoplostoma hirtum* of Marseilles is the same as *Enoplus communis*, Bast., of the English coasts. It is impossible to separate from this species *Enoplus macrophthalmus*, Eberth, *E. Dujardinii*, Bast., and *E. pigmentosus*, Bast. Lastly *Thoracostoma echinodon*, Mar., is synonymous with *Leptosomatum figuratum*, Bast.

It is evident to me that many Nematoids inhabit both the ocean and the Mediterranean. The four species just cited (*Symplocostoma longicollis*, *Phanoderma Cocksii*, *Enoplus communis*, and *Leptosomatum figuratum*), observed by Bastian on the shores of the

British Isles, are very common in the gulf of Marseilles. They live among the seaweeds of the shore, and even resist the impure waters of the harbour of Arene.

This great geographical extension is still more surprising in respect of the freshwater Nematoids. In the pools of La Torse, in the neighbourhood of Aix in Provence, I obtained *Dorylaimus stagualis*, Duj., and *Trilobus pellucidus*, Bast., of the English ponds. Probably M. Villot will find in Brittany most of the species indicated in the Mediterranean. The imperfection of some of Bastian's figures does not enable me, in the case of several worms, to propose an identification which nevertheless may be foreseen.—*Comptes Rendus*, February 22, 1875, p. 499.

*On a new Order of Eocene Mammals.* By Prof. O. C. MARSH.

At the last meeting of the Connecticut Academy, Feb. 17th, Prof. O. C. Marsh made a communication on a new order of Eocene mammals, for which he proposed the name "Tillodontia." These animals are among the most remarkable yet discovered in American strata, and seem to combine characters of several distinct groups, viz. Carnivores, Ungulates, and Rodents. In *Tillotherium*, Marsh, the type of the order, the skull has the same general form as in the bears, but in its structure resembles that of Ungulates. The molar teeth are of the Ungulate type; the canines are small; and in each jaw there is a pair of large scalpriform incisors faced with enamel, and growing from persistent pulps, as in Rodents. The adult dentition is as follows:—incisors  $\frac{2}{2}$ ; canines  $\frac{1}{1}$ ; premolars  $\frac{2}{2}$ ; molars  $\frac{2}{2}$ . The articulation of the lower jaw with the skull corresponds to that in Ungulates. The posterior nares open behind the last upper molars. The brain was small, and somewhat convoluted. The skeleton most resembles that of Carnivores, especially the Ursidæ; but the scaphoid and lunar bones are not united, and there is a third trochanter on the femur. The radius and ulna, and the tibia and fibula are distinct. The feet are plantigrade; and each had five digits, all terminated with long, compressed, and pointed unguis phalanges, somewhat similar to those in the bears. The other genera of this order are less known; but all apparently had the same general characters. There are two distinct families:—*Tillotheridæ*, in which the large incisors grew from persistent pulps, while the molars have roots; and the *Stylinodontidæ*, in which all the teeth are rootless. Some of the animals of this group were as large as a tapir. With *Hyrax*, or the Toxodontia, the present order appears to have no near affinities.—*Silliman's American Journal*, March 1875.

*On the Mediterranean Species of the Genus Eusyllis.*

By M. A. F. MARION.

I have lately indicated, under the name of *Eusyllis lamelligera*, an annelide of the Gulf of Marseilles, belonging to the remarkable

genus established by Malmgren for some Syllidians from Spitzbergen. I have since been able to examine several individuals of the species, and I have constantly recognized the existence of a lamellar first ventral cirrus, which acquires a great development and contrasts with the homologous organs of the following segments. The hooks of the composite setæ are all very long and of a peculiar form. I am now able to appreciate better these differential characters, as I have before me other specimens of *Eusyllis* very distinct from the former, and which cannot be separated from *Eusyllis monilicornis*, Malmg.; these come from the deep coralligenous regions.

These Annelides attain a length of 10 millims., and possess 50 setigerous segments. The cephalic lobe is deeply set in the buccal ring, which advances above it, forming a small dorsal gibbosity. We observe two pairs of principal eye-spots, and a supplementary pair of small eyes placed at the base of the outer antennæ. All the appendages are irregularly articulated; the first dorsal cirrus attains a considerable length, and is often rolled up in the manner of the organs of *Autolytus*. The two palpi are greatly developed, and soldered together at their base. The pedal mamillæ are all very prominent, and bear pinniform ventral cirri. The ventral cirrus of the first segment, however, is always smaller than those of the following segments, whilst we find a contrary arrangement in *Eusyllis lamelligera*. The trunk occupies the first five zoonites; the denticles with which its aperture is armed seem to be much larger than those of *Eusyllis lamelligera*. The proventriculus is succeeded by a colourless region furnished with T-shaped glands; and the intestine presents no very deep constrictions.

All these characters agree with Malmgren's figures and description. Each foot is supported by a strong hooked acicula. The composite setæ bear rather short bidentate hooks, identical with those of *Eusyllis monilicornis* from Spitzbergen; but in the midst of them I find a slender recurved stem, terminated by two little points. This organ exists in all the feet; it is quite independent of the dorsal filiform setæ which appear at the time of sexual maturity.

From these observations it appears that the genus *Eusyllis* is represented on the shores of the Mediterranean by two very distinct forms. One is perhaps peculiar to the Mediterranean; it has not yet been indicated in any other sea. The other, on the contrary, belongs to a type which is diffused even into the Arctic regions. It is evident that it only requires careful investigation to increase the number of species common to the Mediterranean and the ocean. I have ascertained that the *Hermellæ* of the shores of Provence do not differ from those of the English Channel and of the Scandinavian coasts; and the *Psamathe cirrata* of Saint-Vaast exists in the coralligenous gravels of Montredon. We cannot, therefore, overlook the bonds which unite the Mediterranean and oceanic faunas, although the autonomy of these faunas is nevertheless indisputable. —*Comptes Rendus*, February 22, 1875, p. 498.

# THE ANNALS

AND

## MAGAZINE OF NATURAL HISTORY.

[FOURTH SERIES.]

No. 89. MAY 1875.

XXXVIII.—*On the Articular Bone and supposed Vomerine Teeth of Ctenodus obliquus; and on Palæoniscus Hancocki, n. sp., from the Low Main, Newsham, Northumberland.* By THOMAS ATHEY.

[Plate XIX.]

### *Ctenodus obliquus.*

In a communication made by my late friend Mr. Albany Hancock and myself to the 'Annals and Magazine of Natural History,' ser. 4. vol. vii. p. 190, we pointed out the close relationship that exists between the mandible of *Ctenodus* and that of the recent *Ceratodus*, and showed that the upper outer border of the dental plate of *Ctenodus* is unsupported. At the date of that communication the articular bone of *Ctenodus* had not been identified as such.

For a good many years I had occasionally obtained from the black stone overlying the Low-Main seam of coal at Newsham, near Blyth, Northumberland, an angular bone associated with the cranial bones of *Ctenodus*, but could not make out to what precise part of the head it might belong, until about three years ago, when Sir Philip Egerton kindly sent me for examination two palatal teeth and a mandible of the recent fish *Ceratodus Forsteri*, brought from Queensland, Australia. A glance at the specimens showed that the bone respecting which I was in doubt was the articular bone of

*Ctenodus*, corresponding exactly as it did in conformation to the articular bone of the recent *Ceratodus*.

Last year (1874) I was fortunate enough to find, also at Newsham, two fine specimens of *Ctenodus obliquus* with this very articular bone *in situ*; and one of these is figured on Plate XIX. figs. 1 and 2.

The bones differ in size, being from  $\frac{3}{4}$  of an inch to 4 inches in length. The inner side of the mandible is formed by the ramus or body of the jaw surmounted by the teeth; and these at their upper margins are turned outwards and flattened, and project towards the upper border of the articular or external piece. The narrow elongated space left between the two bones of the fossil at this part would necessarily in the fresh state be filled with connective cartilage and ligament, just as the corresponding space is in the recent *Ceratodus Forsteri*.

The articular bone of *Ctenodus* is of about the same length as the inner plate or ramus which bears the teeth, slightly convex on the outer surface, and marked by five or six apertures for vessels; it is pointed upwards in front like the prow of a boat. Its posterior border presents two scallops, the upper somewhat larger than the lower, which extends to the posteriorly projecting point of the lower border, which is convex; the upper scallop ends at a rounded projection, which separates it from the upper border. This border presents two shallow concavities, the anterior occupying the greater part of the border; the posterior has a projection on its inner side, somewhat in the form of a bracket, for the support of the teeth of the inner plate or ramus.

On a thin slab of shale from Newsham in my possession, and which measures 5 by  $3\frac{1}{2}$  inches, are seen imbedded one rib, several bones of the head, fragments of scales, and what I take to be right and left vomerine teeth of *Ctenodus*, one of which is figured on Plate XIX. fig. 4. The teeth are  $\frac{1}{16}$  of an inch broad, and thick at the base—their outer surfaces being slightly convex and their inner slightly concave, the two surfaces converging from the base to the thin, convex, serrated or toothed margin, which is  $\frac{2}{16}$  of an inch long. The microscopic structure of these teeth corresponds exactly with that of the maxillary teeth of *Ctenodus*.

I possess about a dozen other specimens believed to be vomerine teeth of *Ctenodus*, in close proximity on the same slabs to the bones of the head and teeth of *Ctenodus*; some of these are a little larger, others a little smaller, than the two above described.



*Palaeniscus Hancocki*, n. sp.

This elegant little fossil fish I have ventured to name after my late lamented friend Mr. Albany Hancock.

It measures from  $2\frac{1}{2}$  to  $3\frac{1}{2}$  inches in length, and its depth immediately behind the pectoral fin  $\frac{1}{10}$  of an inch; this is maintained as far as the ventral fin, beyond which it diminishes towards the tail: the body is therefore long and slender. The fins are small; the articulations of each of the rays of the pectoral are very distant, those of the ventral, anal, and dorsal less so; the rays of the ventral, anal, and dorsal are more slender than those of the pectoral. So far as can be made out, the tail is delicate, the upper lobe somewhat longer than the lower. There are two conspicuous rows of scales on the side of the ventral part of the body near the margin: these scales are twice as high as they are wide; their external surface is smooth, and their posterior margin finely serrated. The other scales are only about half the size of the above mentioned, and of rhomboidal form. The head, in length, is about the sixth part of the body. The teeth are very minute, and of two sizes (larger and smaller), sharp-pointed, and set closely in the jaw. The mouth is large; the maxillæ and mandibles and the bones of the upper surface of the skull are covered externally with a delicately sculptured and shining pattern of convoluted ridges and grooves, the former of which are flattened. The operculum is large and smooth, the suboperculum less. Eight branchiostegal rays exist, and project beyond the line of the mandible, the one next to the pectoral fin being by far the largest. The lower border of the mandible is furnished with a row of projecting points, continuations of the ridges on the side of the mandible.

The above characters so clearly separate *P. Hancocki* from other *Palaenisci* that I am in doubt whether or not it should be ranked as a member of the genus; but I have given the name *Palaeniscus* to it provisionally, in order to bring the fossil to the notice of palæontologists. It is from the Northumberland Coal-measures, and has been found in the black shale of the Low Main at Newsham, Cramlington, and Kenton.

NOTE.—I take the present opportunity of correcting two errors into which Mr. Miall appears to have unconsciously fallen. First, in his paper in the 'Journal' of the Geological Society for December 1874, he says:—"A restoration of the palate of *Tenodus cristatus* forms one of the illustrations of Messrs. Hancock and Atthey's series of papers on the Fishes

and Labyrinthodonts of the Northumberland coal-field." Now the illustration here referred to is not a restoration of the palate of *C. cristatus*, Agassiz, but of that of *C. tuberculatus*, nobis. Secondly, he states that we describe the upper surface of the tooth of *C. cristatus* as convex, whereas in reality we state that it is "somewhat hollowed or concave." Our paper noticed by Mr. Miall was published in the 'Nat. Hist. Trans. of Northumberland and Durham,' vol. iii. p. 61, the illustration referred to in vol. iv. pl. 14.

#### EXPLANATION OF PLATE XIX.

- Fig. 1.* Outside view of right mandible of *Ctenodus obliquus*, nat. size.  
*Fig. 2.* Right mandible, seen from above: *a*, articular piece; *d*, dental plate; *s*, symphysis of jaw.  
*Fig. 3.* Left pterygo-palatine bone, with dental plate attached, of *Ctenodus obliquus*, nat. size: *a*, anterior end; *pt*, pterygoid border; *p*, palatine border; *s*, symphysis; *sp*, rough surface for articulation with the sphenoid bone.  
*Fig. 4.* Vomerine tooth of *Ctenodus*, nat. size: *a*, front, *b*, side, *c*, back view.

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XXXIX.—Notes on some Young Stages of *Umbellularia*, and on its Geographical Distribution. By R. v. WILLEMOES-SUHM, Ph.D., Naturalist to the 'Challenger' Expedition.

[Plate XVIII. A.]

SINCE *Umbellularia* was rediscovered by the Swedish Expedition to Greenland, the attention of zoologists has been specially drawn to it by a paper, with excellent plates, by T. Lindahl\*, who himself brought it down from the Arctic regions. Another note has been published by Prof. Kölliker† on specimens of *Umbellularia* which were brought up during H.M.S. 'Challenger's' cruise in the Atlantic, and sent to him for description by the hydrographer. Both authors were kind enough to send us their papers; and as in the mean time we got a good many more *Umbellularia*, and even young stages of them, I think a few notes on the geographical distribution of the genus as far as it is now known to us will be welcome to zoologists, as also will a few figures of the earliest stages which we brought up in the Antarctic Ocean.

\* "Om Pennatulidsläktet *Umbellula*," Kongl. Svenska Akademiens Handlingar, Bandet xiii. No. 3, Febr. 10, 1874.

† 'Ueber den Bau und die systematische Stellung der Gattung *Umbellularia*,' Würzburg, 2. Mai, 1874.

*Umbellularia Thomsonii*, Köll., was found in the Atlantic three times:—

1. Between Cape St. Vincent and Madeira, in lat.  $35^{\circ} 20'$  N., long.  $134\frac{1}{2}^{\circ}$  W., at a depth of 2125 fathoms. The specimen is the largest that has been found; length, according to Kölliker, 89.5 centims.

2. 300 miles to the eastward of St. Paul's rocks, lat.  $1^{\circ} 47'$  N., long.  $24^{\circ} 26'$  W., at a depth of 1850 fathoms. This is the smaller specimen which was sent to Prof. Kölliker, who says it has a length of 27 centims.

3. On the coast of Brazil, off the mouth of the San Francisco river, lat.  $10^{\circ} 11'$  S., long.  $35^{\circ} 22'$  W., in 1600 fathoms. A half-grown specimen.

In the Antarctic sea we brought up five times different stages of an *Umbellularia* which is very much like the Atlantic species; but whether it is the same or not could not be decided, as the specimens of the latter had already been sent to Europe. The Antarctic species was found in the following localities:—

1. Halfway between Prince Edward's and Crozet Islands, lat.  $46^{\circ} 46'$  S., long.  $45^{\circ} 31'$  E., at a depth of 1375 fathoms. A half-grown specimen.

2. 84 miles to the westward of Hog Island (Crozet), lat.  $46^{\circ} 16'$  S., long.  $48^{\circ} 27'$  E., at a depth of 1600 fathoms. A full-grown specimen of nearly the same size as the first one found in the Atlantic.

3. Near the ice-barrier, lat.  $62^{\circ} 26'$  S., long.  $95^{\circ} 44'$  E., at a depth of 1975 fathoms. Several very small and middle-sized specimens, some of which will be described hereafter.

4. On our way from the ice-barrier to the north, lat.  $53^{\circ} 55'$  S., long.  $108^{\circ} 35'$  E., at a depth of 1950 fathoms. Rather small specimens.

5. South of Australia, lat.  $42^{\circ} 42'$  S., long.  $34^{\circ} 10'$  E., at a depth of 2600 fathoms. Middle-sized specimens.

We also found an *Umbellularia* in the Pacific, at a depth of 2440 fathoms, to the south-west of the Louisiade archipelago, where two specimens were brought up, which very likely are different from all those which we got before, as the polyyps appeared to be more flattened, wider, and shorter.

During our cruise through the Malayan archipelago none of these Pennatulids came up.

According to these data, *Umbellularia* was never found by the 'Challenger' in such comparatively shallow water as that in which it has been obtained off the coasts of Greenland. In the neighbourhood of the Antarctic islands it was often found in very deep, never in shallow water.

The following is a list of all the depths from which *Umbellularia* has been brought up:—

1. Off the coasts of Greenland: 236 fathoms (*Adrians*), 410 and 122 fathoms (*Lindahl*).

2. In the Atlantic: 1600, 1800, and 2150 fathoms.

3. In the Antarctic sea: 1375, 1600, 1975, 1950, and 2600 fathoms.

In the Pacific in 2440 fathoms.

The greatest depth at which this Expedition procured *Umbellularia* is accordingly 2600 fathoms, the least 1375 fathoms. It is usually associated with such decidedly deep-sea animals as *Ophioglypha*, *Brisinga*, *Pourtalesia*, Ananchytids, Munopids, *Petalophthalmus*, *Gnathophausia*, *Macrurus*, &c.

After these remarks on its geographical distribution as far as it is known to us at the present moment, I shall proceed to give a few details on its young stages, which were found at station no. 3 in the Antarctic sea, and which show, better than the full-grown specimens of Lindahl and Kölliker, the very marked bilateral symmetry of the polypary and the order in which the polypes succeed each other.

Lindahl has given, on page 8 of his paper, an ideal sketch of what he thinks to have been the successive appearance of the polypes on the polypary. According to him, the oldest or terminal polyp ( $\tau$  in his and in my figures) remains during the first five stages at the top, above the others. Then only the lateral polypes (I. and II.) come forth, and two of them advance to the top, while the terminal one is removed towards the centre.

In the Greenland species of *Umbellularia* this may be perfectly correct, but in the Antarctic species, of which we actually got the young stages, the mode of growth is a little different. This will be confirmed by a glance at my figures. The smallest specimen (Pl. XVIII. A. fig. 1), having only a length of 41 millims., shows clearly that here also a terminal polype ( $\tau$ ), which is 2 millims. longer than the lateral ones, has first made its appearance. The lateral ones have come out a little later, but both at the same time, not the right one earlier than the left, as is supposed in Lindahl's diagrammatic figures. The same stage is represented by a larger specimen (fig. 3), length 100 millims., in which the terminal polype is still the largest, but in which the lateral ones are already nearly of the same size. The reason why in this large specimen there are only three polypes, while a much smaller one now to be described has already four, is probably want of food.

The first change which takes place is the coming out of

another terminal polype, which is effected by the first polype (hitherto at the top) being removed a little towards one side; and we now get an arrangement (fig. 4) in which there is a polype close to the top on each side of the end of the rachis, or they both grow out at right angles from the latter; and the polypary now, as in fig. 2, presents a perfectly symmetrical arrangement, viz. two polypes on one side and two on the other.

The *end of the rachis* is clearly visible in fig. 1, which has been drawn from a specimen made transparent; and it is indicated by a knob in fig. 2. *Spicula* were not visible in fig. 1. *Zooids* are first to be seen on the ventral side of fig. 2, and so they are in fig. 3; in the largest of the specimens here figured they cover the ventral side of fig. 4 *a*, but leave free a middle line on the dorsal end of the same.

The mode of growth of the polypes in this Antarctic *Umbellularia* is therefore, so far as our specimens show, as follows:—

1. The terminal polype comes out (fig. 1).
2. The terminal polype grows, and two lateral ones come out (figs. 1 and 3).
3. The terminal polype loses its place by another one coming out, and is removed towards the side (figs. 2 and 4). There are now on each side a terminal and a lateral polype (according to Lindahl's nomenclature).
4. A fifth polype is coming out in the centre of the polypary (fig. 2 *b*, III.); and the rest of the polypes very likely come out below the first two lateral ones.

In the earliest stage there are neither spicula nor zooids; the latter, when they have come out, leave a line free on the dorsal side of the polypary.

H.M.S. 'Challenger,'  
Manilla, January 1875.

#### EXPLANATION OF PLATE XVIII. A.

All the figures give the natural size of the polypes. In fig. 1 the rachis has been put in as seen by a low magnifying-power. Letters the same in all the figures:—*T* = terminal polypes; *I.* and *II.* = lateral polypes; *III.* = third lateral or fifth polype; *Z* = zooids.

*Figs. 1-4.* Young stages of *Umbellularia* sp.?, found near the antarctic ice-barrier, lat. 62° 26' S., long. 95° 44' E., in a depth of 1975 fathoms.

*Fig. 1.* From the ventral side. Length 41 millims.

*Fig. 2 a*, from the ventral side; *2 b*, from the dorsal side. Length 52 millims.; length of polypes 7-8½ millims.

*Fig. 3.* From the ventral side. Length 100 millims., of polypes 11 millims.

*Fig. 4 a*, from the ventral side; *4 b*, from the dorsal side. Length 385 millims., of polypes 15 millims.

XI.—On a third new Tertiary Species of *Trigonia*. By  
 FREDERICK M'COY, Professor of Natural Science in the  
 University of Melbourne.

[Plate XVIII. B.]

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

GENTLEMEN,

The genus *Trigonia* has furnished an extraordinary apparent exception to the usual distribution of genera in time, according to which a genus living in the older periods of the world's history, and becoming extinct during a subsequent geological period, is not found to reappear at a still more recent epoch. *Trigonia* abounding in the whole of the Mesozoic periods from the Lias to the Chalk, represented by many species, seemed suddenly to become extinct with the commencement of the Eocene Tertiary period, and, being absent in all known Tertiary formations, seemed to reappear in the present seas of Australia; and as none of the well-searched Tertiary deposits of Europe or America showed any trace of such shells, a well-defined case of exception to the above-mentioned rule seemed established, until some years ago I described two species, distinct from the living ones, found in the Tertiary formations near Melbourne with *Aturia*, *Carcharodon angustidens* and *C. megalodon*, *Otodus Desori*, *O.cyrhina trigonodon*, *Squalodon* (*Phocodon*), and other clearly characteristic Tertiary as distinguished from modern types.

As therefore the announcement of the fact will probably be of interest both to zoologists and geologists, I beg to forward you a figure and description of a third Tertiary species of the genus, which I have lately recognized amongst some specimens sent to me, as Palæontologist of the Victorian Geological Survey, from the eastern portion of the colony, the district of Gippsland, of which hitherto comparatively little was known.

*Trigonia Howitti* (M'Coy).

*Spec. char.* Rotundate rhombic; substance of shell thick; tumid towards the beak, anterior side rounded, posterior slope moderately flattened in two planes divided by a very obtuse angle marking the margin; ventral margin moderately convex, posterior edge nearly at right angles to the ventral edge, slightly rounded in respiratory portion, forming an angle of about 150° with hinge-line in anal portion; about four narrow quadrate radiating ridges on each division of the posterior slope, sharply separated by deep flattened spaces equal to about their own width; about fourteen thick, prominent, rounded radiating

ridges from the beak to the ventral margin, separated by slightly narrower deep concave spaces; near the beak (for about half an inch) all the ribs set with strong blunt transverse tubercles, about their own thickness apart (about five in two lines), but on the adults the middle and lower ends of the ribs are marked only with irregular lines of growth, like the intervening hollows, except the seven or eight anterior ones, on which the large blunt tuberculation is continued to the ventral margin (about three in two lines). Length from anterior to posterior end 2 inches 3 lines; proportional width from beak to opposite margin  $\frac{2.9}{100}$ ; depth of one valve  $\frac{3.4}{100}$ ; hinge-line  $\frac{3.5}{100}$ .

This species is much larger, thicker, and stronger than the living or the other two Tertiary species, and is readily distinguished by the tuberculation (except near the beak) being confined; the anterior ribs having, the middle and posterior ones only slightly wrinkled by, lines of growth. The inner edge is strongly toothed by the projecting ends of the channels between the radiating ribs. Sometimes the two small most posterior ridges bear tubercles.

This species was collected by Mr. Howitt from the beds of sandy marl at Jemmy's Point, near the entrance of the Gippsland lakes, containing *Struthiolaria* and other forms which I have observed in the Pliocene Tertiaries of New Zealand, but not of any other locality in Victoria. I have great pleasure in naming so interesting a fossil after so excellent and zealous a geologist as Mr. Howitt has proved himself in the Gippsland district.

## XLI.—*Zoologico-Embryological Investigations*.

By M. USSOW.

[Concluded from p. 221.]

### CEPHALOPODA (*conclusion*).

To render clearer all the processes described by me, I think it will be useful to enumerate once more the principal facts of the embryonal development of the above-mentioned Cephalopoda in their normal sequence.

After the greater part of the protoplasm of the primitive ovicell, or the formative vitellus which surrounds as with an envelope the whole mass of the transparent fatty fluid (nutritive vitellus) has been converted, in the manner already described (see the process of segmentation), into a layer of flat

or cylindrical cells (more elevated at the upper, pointed pole of the egg) forming the blastoderm or upper germ-lamella (horn-lamella, sensory lamella), on the second (*Argonauta*) or third (*Loligo*, *Sepiöla*) day of development a second lamella originates in the middle part (*area opaca*) of the germinal disk, *by transverse division of the upper germ-lamella*; and this, during the period of the appearance of the organs, plays the part of the middle germ-lamella of the Vertebrata, Annulosa, Mollusca, &c., and like that lamella soon divides, in some of the animals mentioned, into two layers, the dermo-muscular and the intestino-fibrous layers.

From the lamella thus dividing, and indeed from the upper first lamella which becomes inverted on the two opposite (ventral and dorsal) sides of the embryo, the young Cephalopod is developed upon the broad hemispherical germinal spot or disk, extending as far as the equator of the egg, in from 25 (*Argonauta*) to 40 days (*Loligo*). The lower part of the germ, which in most of the species mentioned closes over the obtuse pole of the egg at the end of the first period, becomes the yelk-sac, composed of the upper lamella and the dermo-muscular layer.

Development commences in the central part of the germinal disk, and, indeed, by the appearance on the future dorsal surface of the animal of an at first insignificant furrow, which rather quickly acquires the form of a groove and subsequently becomes converted into a perfectly closed tube.

Simultaneously with the primitive groove appears the rudimentary mantle, surrounding it and gradually growing together over it, which separates by constriction at first from the ventral side, but afterwards and more slowly also from the dorsal side.

Then there appear one after the other the eye-ovals, the rudiment of the anterior part of the intestinal tract, the paired rudiments of the branchiæ, funnel, arms, and auditory organs, and in the original solid anal tubercle the pit-like depression, which is afterwards converted into the ink-bag and the hinder part of the intestinal canal (rectum).

At a later period than the above-mentioned organs, the central organs of circulation (auricles, ventricles, &c.) and those of the nervous system (the paired ganglia optica, cerebralialia, pedalia, visceralialia, buccalia, and stellata, and the unpaired ganglion splanchnicum) make their appearance.

All the organs appearing in the sequence just indicated are developed from three different germ-lamellæ in one of two ways:—either as a local thickening (excrescences and internal thickenings) sometimes of the upper, sometimes of one or other layer of the middle lamella, or as an invagination or



inversion of the upper lamella. In the former case the upper lamella frequently plays the part of a thin external envelope to the rudimentary organ, consisting of the dermo-muscular or intestino-fibrous layer; or it splits into several layers, the lower of which form the organ proper. In the second case the upper lamella forms various depressions at different parts of the germinal disk, and penetrates into the middle lamella, which thus forms the envelope of the organ.

The following Table furnishes a summary of the mode of appearance of each organ :—

Local thickening.	Outgrowth	of the upper lamella		The eye-ovals.
		of the middle lamella.	of the dermo-muscular layer.	The mantle, fins, branchiæ, funnel, arms, organ of taste.
			of the intestino-fibrous layer.	The anal tubercle (anal lobe).
	Internal thickening	of the upper lamella.		All cartilages.
		of the middle lamella.	of the dermo-muscular layer.	All central and peripheral ganglia.
			of the intestino-fibrous layer.	The auricles and ventricles.
Invagination or depression	of the upper lamella.		The primitive groove, auditory organs, olfactory organs, the anterior and posterior parts of the intestinal tract, the ink-bag, the efferent ducts of the salivary glands.	

As regards the stomach (and also the so-called crop), the cæcum, and the liver, these are secondary formations, originating from dilatations of the original intestinal tube; the salivary glands and the so-called branchial hearts must also be reckoned secondary organs.

To show the part taken by the different germ-lamellæ in the formation of the various organs, I add the following Table:—

The upper lamella.	The walls of the tube in which the <i>os Sepiæ</i> is formed, the epidermis (the outer skin of the whole body and the external covering of the funnel and branchiæ), the organs of sight, hearing, and smell, the pericardium, all the cartilages (of the head, eyelids, funnel, &c.).				
The middle lamella.	<table border="1"> <tbody> <tr> <td data-bbox="264 520 419 798">The dermo-muscular layer.</td> <td data-bbox="424 520 901 798">The branchiæ, the arms with their suckers, all the muscles, the cutis (fibrous layer, chromatophores, muscular fibres, &amp;c.), the peritoneum, the branchial hearts, the kidneys, and all the blood-vessels, the organ of taste, the envelopes of the auditory organs, the peripheral and central nervous system.</td> </tr> <tr> <td data-bbox="264 807 419 954">The intestino-fibrous layer.</td> <td data-bbox="424 807 901 954">The walls of the central circulatory system, the auricles, the ventricles, the muscular envelope of the intestinal tract and of the ink-bag.</td> </tr> </tbody> </table>	The dermo-muscular layer.	The branchiæ, the arms with their suckers, all the muscles, the cutis (fibrous layer, chromatophores, muscular fibres, &c.), the peritoneum, the branchial hearts, the kidneys, and all the blood-vessels, the organ of taste, the envelopes of the auditory organs, the peripheral and central nervous system.	The intestino-fibrous layer.	The walls of the central circulatory system, the auricles, the ventricles, the muscular envelope of the intestinal tract and of the ink-bag.
The dermo-muscular layer.	The branchiæ, the arms with their suckers, all the muscles, the cutis (fibrous layer, chromatophores, muscular fibres, &c.), the peritoneum, the branchial hearts, the kidneys, and all the blood-vessels, the organ of taste, the envelopes of the auditory organs, the peripheral and central nervous system.				
The intestino-fibrous layer.	The walls of the central circulatory system, the auricles, the ventricles, the muscular envelope of the intestinal tract and of the ink-bag.				
The intestino-glandular [epithelial] lamella (the invaginated upper lamella).	The inner epithelial envelope of the intestinal tract and of all its subsidiary organs (cæcum, liver), and of the salivary glands and ink-bag.				

Comparing the development of the three Decapoda investigated by me with that of the single Octopod to which I had access, I find a great agreement between them, but with the exception that the primitive groove which I have described in the case of the Decapoda does not close in *Argonauta*. In the time and the mode of appearance of the principal organs (alimentary apparatus, central nervous system, circulatory organs, &c.) in the embryos of the two groups they perfectly correspond.

The unimportant fact of the late appearance of the yelk-sac in *Sepia*, already remarked by Kölliker\*, is the sole peculiarity of that genus that is not reproduced in the other Decapoda.

\* *Loc. cit.* p. 60.

## THE TUNICATA.

With the more accurate knowledge of the anatomy, and especially of the developmental history, of the various species of Tunicata, the notion of the alliance of these animals with the Mollusca (Acephala, Molluscoidea, Himatoga), which was for a long time predominant, finds fewer and fewer adherents among modern zoologists\*. Since the appearance of the epoch-making work of A. Kowalevsky† on the embryology of the simple Ascidia, and of some later‡ no less pregnant and interesting investigations of the same naturalist relating to the same subject, besides the works of Kupfer§, E. Metschnikoff||, Ganin¶, &c., which have confirmed and completed the results obtained by Kowalevsky, the notion of the phylogenetic relationship of the Tunicata to the Vertebrata, and indeed to their lowest form (*Amphioxus*), has gained ground in science. That the separation of the Tunicata from the molluscan type has become necessary in consequence of the investigations just cited is now admitted more or less by all zoologists—some of them, such as Gegenbaur\*\* and E. Häckel††, regarding it as possible to refer the Tunicata to the Vermes; whilst others, such as Oscar Schmidt‡‡, who desire to see classification founded chiefly upon embryological data, form with them a special distinct class of Primitive Vertebrates. On the other hand, there are still a good many naturalists (Lacaze-Duthiers§§, Donitz|||, Hertwig¶¶, Von Baer\*\*\*) who deny all relationship with the Vertebrata to

\* Häckel, Gen. Morph. Bd. ii. pp. cvi, cvii, 413; Gegenbaur, Vergl. Anat. 2te Aufl. p. 474; Huxley, Comp. Anat., Less. v.

† "Entwicklungsgesch. der einf. Ascid.," Mém. de l'Acad. de St. Pétersb. tome x. 1866.

‡ "Weitere Studien über die Entw. der einf. Ascid.," Archiv für mikr. Anat. Bd. vii. p. 101; Nachr. der K. Ges. der Wiss. p. 401, and for 1868; "Ueber die Knosp. der *Perophora Listeri*, Wiegman," Kiew Zapiski, Bd. iii. Div. 1; Zeitschr. für wiss. Zool. 1871, p. 285.

§ Arch. für mikr. Anat. 1869, p. 459, 1870, p. 115, 1872, p. 358.

|| Bull. de l'Acad. de St. Pétersb. tome xiii. p. 293, 1869; Zeitschr. für wiss. Zool. xxii. p. 339, 1872.

¶¶ "Neue Thatsachen aus der Entwicklungsgesch. der Ascid.," Zeitschr. für wiss. Zool. 1870, p. 512.

\*\* Vergl. Anat. 2te Aufl. (1870), pp. 158, 474.

†† Natürl. Schöpfungsgesch. 4te Aufl. (1873), pp. 448, 466, 467.

‡‡ Vergl. Anat. 6te Aufl. (1872), p. 248.

§§ "Rech. sur l'organ. et l'embryog. des Ascidiées," Comptes Rendus, 1870, p. 1154.

||| Arch. für Physiol. 1870, p. 762.

¶¶ Jen. Zeitschr. Bd. vii. (1872), p. 46.

\*\*\* Mém. de l'Acad. de St. Pétersb. tome xix. (1873).

the Tunicata, and find in them sharply defined characters of the molluscan type.

In my investigations of the Tunicata the task I set myself was, in the first place, to test by personal investigation the exceedingly important results of their developmental history, and, secondly, to clear up as far as possible some gaps and disputed questions in their anatomy. In the latter direction I endeavoured chiefly to investigate:—1, the structure of the nervous system and its mode of transformation from the form proper to the embryonal and larval states, which have hitherto been very superficially observed and described; 2, the intimate structure of all the sensory organs of the Tunicata, which has not yet been satisfactorily ascertained; and, 3, the structure of the inner and especially of the outer mantle, and of the organs of circulation and nutrition, which likewise presented important questions still unsolved.

The following forms were investigated by me in different directions:—

I. SEDENTARY TUNICATA:—*Ascidia mammillata, intestinalis, canina, mentula*; *Cynthia microcosmus, papillosa, ampuloides*; *Clavellina lepadiformis*; *Botryllus smaragdus, auratus*; *Diazona violacea*.

II. SWIMMING TUNICATA:—*Appendicularia furcata, flagellum, caerulea*; *Pyrosoma gigas*; *Salpa africana—maxima, democratica—mucronata, runcinata—fusiformis, bicaudata, pinnata*; *Doliolum*, Ehrenb., Nordm., Müll.

I now proceed to give a condensed statement of the results of my investigations.

### I. *The Nervous System—its anatomy, minute structure, and mode of formation.*

All the Tunicata investigated by me (except the *Appendicularia*) have a single unpaired ganglion (central ganglion of authors, 0·1–0·15 millim. in diameter), which is both analogous and homologous with the central portion of the nervous system of the lower Vertebrata (*Amphioxus*). It is always situated in the middle line on the *dorsal side* of the animal, close to or not far from the entrance of the respiratory cavity. Both the ganglion and all the peripheral nerves occur in the transparent layer of the inner mantle, in which the muscular bundles and the reticulately fibrous connective tissue (dermo-muscular sac) are also imbedded. The distribution of the nervous elements in the ganglion is very simple and uniform. The usually multipolar nerve-cells (*gymnocytes*) are generally placed in layers in the peripheral part of the ganglion, whilst its

centre is occupied by their processes, which run in the direction of the longitudinal axis of the ganglion.

All the nervous elements, except for their small size (0.003–0.02 millim.) and the complete absence of the so-called sheath (*Markscheide*), differ but little from the elements of the nervous tissue which occur, for example, in the cerebellum, the Hasserian ganglion, and in other parts of the central nervous system of the Vertebrata (especially the Fishes). The so-called œsophageal nervous ring which has been described by some naturalists (Delle Chiaje\*, Eschscholtz†, &c.) is wanting in all the Tunicata examined by me. The number of peripheral nerves developed independently of the ganglion is very different in different species, groups, and generations (*Salpa*). It varies between three single nerves (*Cynthia papillosa*) and thirty-six pairs of nerves (*Salpa maxima*, *pinnata*, *bicaudata*, &c.). Peripheral ganglia occur in the *Appendiculariæ*, while in all other Tunicata no such ganglia are met with either in the embryonic or in the fully-developed state. The *ganglia caudalia* of the *Appendiculariæ*, from ten to eighteen in number, which are united by means of an inferior nerve of the central ganglion, form a chain‡ extending into the tail, running over the so-called axial cord (like the *chorda dorsalis*). A something in common in the plan of structure of the nervous system of the *Appendiculariæ* and that of the embryo and larva of the Ascidia is presented by the division of their central ganglion into three parts, which are particularly observable in *Appendicularia flagellum*. The central ganglion of this animal is divided into:—1, an upper conical part, with three pairs of nerves; 2, a middle, spherical part, with the auditory vesicles seated upon it; and, 3, a lower wedge-shaped part, with two paired nerves and an inferior unpaired nerve, the latter forming as it were the continuation of the ganglion and extending to the extremity of the tail. We find a similar division of the central ganglion (sometimes with a trace of the central cavity or “central canal”) in very young fixed Ascidia, e. g. the *Cynthia* (*C. microcosmus*). The nervous system of the Tunicata in the retrograde state can by no means be compared with the nervous system of the Mollusca (Baer), either with regard to the morphological plan of its structure or, still more, as respects the type of its embryonal development.

\* Notom. degli Anim. Invert. vol. iii. pp. 28, 29.

† Isis, 1824, p. 5.

‡ Müll. Arch. 1846, p. 106; Leuckart, Zool. Unters. Heft ii. p. 85; Phil. Trans. 1851, p. 596, tab. xviii. fig. 2 m; Kowalevsky, Entwicklungsgesch. der einf. Ascid. p. 13; Kowalevsky, Kiew Zapiski, vol. iii. part 1, p. 47.

The complete absence of the œsophageal nervous ring which exists in the Mollusca, and indeed is characteristic of them, the unity in the structure of their central ganglion, and the development of all parts of their central nervous system from the upper germ-lamella in the form of a nervous ring becoming segmented into three parts are facts which decidedly negative the homology erroneously ascribed to them (the so-called siphonal ganglion in *Teredo navalis*\*).

From a comparative revision of the nervous system in the different species of Tunicata, the following conclusions may be drawn:—in the *Appendicularia* the plan of structure of the nervous system is in some degree like that of the Ascidia; the nervous system of the *Pyrosomata* may be regarded as a transition form between the transformed nervous system of the adult Ascidia, and the type of structure of the nervous system of the *Salpæ* and *Cyclomyariæ*.

The *process of transformation* of the nervous system of the Ascidian larvæ commences immediately after their attachment (so-called sessile form). The ganglion is formed by multiplication of the embryonal cells, which chiefly occupy the lower part of the upper sensory vesicle and the upper part of the trunk-vesicle. The caudal part ("dorsal cord") of the embryonal nerve-tube is atrophied without leaving any traces. The pigment of the visual and auditory organs, and all other parts of the dissolving nervous system of the Ascidian larva, become converted into fat-drops, which are gradually absorbed by the young nerve-cells, with which the narrowing cavity of the nerve-vesicle is more and more filled. The formation of the blood-corpuscles is not dependent upon the above-mentioned metamorphosis of the vanishing embryonal system †. In this way the transformation of the embryonal nervous system into a central ganglion is effected. The ganglionic membrane is developed from the outer cell-layer of the young ganglion. At the time of the formation of the branchial fissures the ganglion is already almost completely developed. Numerous processes of cells of the nervous vesicle, which are at first spherical but gradually elongate and divide, gradually fill up its original cavity. The development of the peripheral nerves is effected by means of a chain-like coalescence of individual nerve-cells which occupy the inner mantle. The finely granular protoplasm of these cells may be regarded as the original substance from which the fibrillar axial cylinders of the nerve-threads are formed. The stellate cells of the connective tissue form by coalescence the neurilemma of the above-mentioned nervous bundles.

\* Von Baer, *loc. cit.* p. 21.

† Müll. Arch. 1852, p. 317.

## II. *The structure and mode of formation of the Sensory Organs.*

1. The *tactile nervous apparatus* which are met with in all Tunicata may be classified as follows, in accordance with the peculiarities of their structure:—

*a.* Simple, very uniformly constructed apparatus. The peripheral multipolar cells (of indubitable nervous nature) united with the thin terminal ramifications of the nerves\* emit numerous processes, which unite directly with the protoplasm of the epithelial cells ("nerve-epithelium") of the inner mantle.

*b.* More composite tactile organs of the Tunicata are bacilli-form, acutely pointed processes† of similar but rather smaller peripheral nerve-cells, sometimes uniting in groups (Doliolidæ). These processes occur in the lips and some other parts of the inner mantle in some species of natatory Tunicata (Salpidæ, Doliolidæ).

2. *Olfactory organs.*—The so-called ciliated pit of undoubtedly nervous nature, which is not unfrequently combined with a special nerve (*nervus olfactorius*—*Salpa*, *Doliolum*, *Pyrosoma*, &c.), is developed in the form of a depression of the epithelial layer (of the upper germ-lamella) of the inner mantle. At first it contains only one cavity (which persists throughout life in *Doliolum*, *Pyrosoma*, and some genera of Salpidæ), the walls of which then become repeatedly folded, and thus form more or less numerous curved vibratile cavities (in most of the sedentary Tunicata and many genera of Salpidæ). In *Ascidia mammillata* the number of simple ciliated cavities rises to two hundred, which are united among themselves by means of ramifying cæcal ciliated tubes situated, like the cavities, in the transparent middle layer of the inner mantle. In the *Ascidia* just mentioned the openings of the ciliated pits occur in the internal space (atrial chamber, Huxley), between the inner epithelial layer and the wall of the branchial sac. In the cavities there is always only a one-layered vibratile epithelium, sometimes surrounded by peculiar spherical pigment-cells, the number of which appears to increase with the age of the animal (especially in *Ascidia mammillata*).

3. *Auditory organs.*—The so-called auditory vesicles occur:—*a.*, unpaired, singly (*Appendiculariæ*, *Cyclomyariæ*);

\* Similar cells are mentioned by Leuckart, Zool. Unters. Heft ii. p. 23, as also in the Heteropoda and other Mollusca, Zeitschr. für wiss. Zool. iv. p. 325; see also Böll, Beitr. zur vergl. Histol. p. 20.

† As in other Mollusca. See Leydig, Lehrb. der Histol. p. 212; Schultze's Archiv, p. 448, Taf. 25. fig. 6.

*b*, paired, without canals (*Pyrosoma*\*); and *c*, paired, and furnished with two canals (*Salpidae*†). The position of the auditory vesicles is very different in different species of Tunicata. They are often situated in the neighbourhood of the central ganglion (*Appendicularia*, *Pyrosoma*, *Salpidae*), and are always united either with a special nerve (*nervus acusticus*) which terminates in their thin walls, or with a short peduncle of the ganglion (*Appendicularia*, *Pyrosoma*). In the *Salpidae*, in which they have the form of shallow funnels, the auditory vesicles are closely applied to the ganglion by their base, whilst the spirally twisted canals issuing from their apex open by wide apertures into the branchial cylinder. Within the auditory vesicles are lined with simple epithelium, in which no bacillar processes are perceptible. The number of shining calcareous otoliths, which are sometimes coloured (*Pyrosoma*), enclosed both in the auditory vesicles themselves and in their canals (*Salpidae*) is very various: in the *Appendicularia* and *Cyclomyaria* there is usually only one, whilst in *Pyrosoma*, and especially in the *Salpidae*, their number is very considerable. To my great regret, I am unacquainted with the development of the auditory vesicles.

4. *Visual organs.*—These organs are developed in the Tunicata, either by a depression of the epithelial layer of the inner mantle (ocelli of the simple and social *Ascidia*), or by the anterior wall of the upper vesicle of the embryonal nerve-tube being pushed out‡ (*Salpa*, *Pyrosoma*). They make their appearance very late in all *Ascidia*; but in the sedentary Tunicata they are to be seen already in the embryonal state. The pigment of the visual organs, which at first consists of round and slightly coloured, and subsequently of hexagonal united cells, is developed from the same embryonal cells of the outer layer of the above-mentioned part of the nervous system. The simple eyes of the *Ascidia* (*Ascidia intestinalis*, *mentula*, *canina*, &c.) are very numerous (8'6). In the *Pyrosomata* and many groups of *Salpae* the eye is usually unpaired (*Salpa fusiformis*, *africana*—*maxima*, *democratica*—*mucronata*); in the rest it is paired (*Salpa bicaudata*), and even triple (*Salpa pinnata*). The outer surface of the eye is turned sometimes towards the respiratory or anterior orifice (*Ascidia*, many *Salpae*), sometimes towards the cloacal or posterior

\* Whilst one, in *Pyrosoma gigas*, lies beneath the central ganglion, the other occurs on the inner surface of the tubular lip of the anterior orifice.

† See H. Müller's description, *Zeitschr. für wiss. Zool.* p. 330; Leuckart, *loc. cit.* Heft ii. p. 25.

‡ As described by Kowalevsky in *Salpa* (*Götting. Nachr.* 1868, p. 410).



opening (*Pyrosoma*), and with paired or triple eyes towards both openings. In all groups of the *Salpæ* and *Pyrosomata* the eyes are united to the central ganglion by means of a peduncle of greater or less length (*nervus opticus*); while in the *Ascidia*, in which their distance from the ganglion is considerable, the union is effected by thin ramifications of the anterior pair of nerves. The eyes, which are usually of a more or less oval form, are either furnished with internal cavities\* filled with a transparent substance (*Ascidia*, *Pyrosoma*), or destitute of these so-called eye-chambers (*Salpæ*). In the latter case the clavate extremities of rather long bacilliform processes of the nerve-sheath, which fill the whole eye, form a hemisphere. The eyes furnished with chambers have, besides the attenuated epithelial layer of the inner mantle which covers them, a thin proper sheath (*Ascidia*), or (in *Pyrosoma*) contain also a vertical transparent lenticular body composed of concentric layers (just as *e. g.* in *Anodonta*). When the eye-chambers are wanting, the structure of the eyes is similar to that of the Insects and higher Crustacea; in other words, it approximates to the type of the compound faceted eyes.

Thus in the mode of development and structure of the visual organs in the Tunicata (except the Appendiculariidæ and Doliolidæ†, which display no trace of eyes) we meet with different types of structure.

While the so-called "ocelli" of the *Ascidia* represent the eyes of the lower Crustacea and Vermes, the compound eyes of the *Salpæ* are homologous with the visual organs of the Arthropoda; the single eye of the *Pyrosomata*, which is furnished with a lens, may even be likened to the visual organs of some Mollusca. The fact that, when compared with the sedentary Tunicata, the natatory forms with an equal or even smaller size of the central ganglion possess a greater number of peripheral nerves, depends very probably upon the greater development of their locomotive organs (annular or ribbon-like muscles). The great number and high degree of development of these, and the much greater development of the sensory organs in the natatory Tunicata, may be explained by the more stirring and energetic mode of life of these animals.

\* F. Will (Freriep's Notiz. 1844) found a flat lens in such Ascidian eyes; but this is not confirmed by my investigations. See also Bronn, Weichth. Abth. i. p. 154.

† In *Doliolum denticulatum*, Nordm., &c. I often found behind the ganglion a simple red aggregation of pigment (sometimes also in some *Botrylli*), which, however, cannot be likened to the so-called ocelli.

III. *The Body-wall.*

The envelope or wall of the body consists in all Tunicata of two contiguous mantles—an outer (*tunica externa*) and an inner one (*tunica interna*).

In most of these animals (especially in the Chthonascidia) the outer mantle consists of three layers:—*a*, a peripheral layer (sometimes wanting) of spiniform cells (*Cynthia*); *b*, a middle, more or less thick, gelatinous fundamental layer of rather firm coalesced sheaths (the so-called “test-cells”), produced from the epithelial cells of the *membrana granulosa* of the Graafian follicle; and, *c*, a third layer, sometimes very thin and scarcely perceptible (*e. g.* in *Ascidia intestinalis*, *canina*; *Salpa*), which is composed exclusively of long elastic fibres, closely applied to the peripheral epithelial layer of the inner mantle (but never coalescent therewith). The outer mantle of the Tunicata is not developed as a product of secretion of the epidermoidal cells of the inner mantle (Hertwig\*, Arsenjew†), but by the multiplication and growth of the above-mentioned “test-cells” (Kupfer‡, A. Kowalevsky§), which are at first arranged in a single layer between the yolk and the vitelline membrane (chorion). The results of my investigations of the formation of the so-called test-cells agree perfectly with those obtained by A. Kowalevsky||. The yellow corpuscles are in fact nothing but cells of the Graafian follicle, which have arranged themselves in a single series round the mature ovicell, and closed upon it before the formation of the chorion. In the larvæ of the simple Ascidia, and in the embryos of the *Salpæ* and *Pyrosomata*, the rudiment of the outer mantle consists exclusively of radiating primitive yellow cells, rapidly multiplying by division, and their intercellular substance. These cells, which put forth numerous processes and not unfrequently change their position (“Wanderzellen,” Kölliker¶), soon coalesce with their sheaths. The contractile protoplasm of such cells gradually disappears (becomes absorbed?). The close network of coalesced thickened sheaths thus forms the porous, vesicular, fundamental substance of the inner mantle, always containing much water (especially in

\* Jen. Zeitschr. Band vii. 1872, p. 46.

† Berichte der Mosk. Ges. für Naturg. und Anthrop. Band x. 1872, p. 86; Jahresb. über die Anat. und Phys. 1873, Art. Tunicata, p. 307.

‡ Schultze's Archiv, Band vi. pp. 149, 159.

§ Entwicklungsgesch. der einf. Ascid. pp. 13 *et seq.*

|| Schultze's Archiv, Band vii. pp. 103 *et seq.*

¶ Ann. Sci. Nat. tome v. p. 220; Müll. Arch. 1852, p. 325; Schultze's Archiv, Band vi. p. 125.

*Phallusia mammillata*). The well-known ramified, claviform, caecal tubes\*, which are met with in the second and third layers of the outer mantle, are developed in the embryos of *Cynthia* and *Phallusia* from five caecal diverticula growing forth from the main ventral artery-vein (*Phallusia mammillata*), and afterwards gradually becoming elongated and ramifying dichotomously.

The whole system of the tubes thus ramified forming two rings (*Cynthia microcosmus*) is nothing but the whole system of the capillary blood-vessels of the outer mantle, which is united to the heart by a thick branch growing forth from the main ventral artery-vein. At the beginning of ramification, the thicker blood-vessels have three-layered walls, possessing an external fibrous layer, a middle one consisting of muscular-fibre rings, and an inner one composed of hexagonal epithelial cells. By the contractions of the muscular layer of the vessels and the pulsations of the heart, the blood is driven to the remotest periphery of the outer mantle. The walls of the fine capillary vessels and their claviform enlargements consist of a simple epithelial layer. The complete circulation of the blood in the outer mantle is effected in two ways:—1. All the vessels, including their enlarged parts, consist of two tubes grown together; and in these double vessels, if they may be so called, the centrifugal stream of blood moves on one side, and at the same time the centripetal one on the other (as may be observed, for example, in the embryos of *Pyrosoma*†). 2. The whole network of blood-vessels of the outer mantle is divided into two parts (*Cynthiae*), viz. *a*, the remoter portion of the blood-vessels, which ramifies near the periphery of the outer mantle, and *b*, the portion of the capillary vessels which are distributed not far from the third fibrous layer of the mantle. If the blood is flowing in the former at a given moment in a direction from the heart, it is flowing at the same moment in the other in an opposite direction, or to the heart. The two portions of the capillary blood-vessels just mentioned are united by lateral branches. In correspondence with the regular change in the direction of pulsation in the heart-tube, the course of the blood changes in all the vessels described by me.

The outer mantle of the Tunicata can be very easily separated from the inner one, and never coalesces with the epithelial cuticular layer of the latter, which, indeed, may be inferred *à priori* from the mode of its formation from the

\* Ann. Sci. Nat. tome v. p. 110, Löwig and Kölliker; Bronn, Weichthiere, Abth. ii. Taf. 3.

† Quart. Journ. Micr. Sci. 1872, p. 283, pl. xii. fig. 9.

above-mentioned layer of test-cells, isolated both from the yolk and from the embryo. The only spot where the outer and inner mantles are more closely united is that branch of the main ventral artery-vein ("*sinus dorsalis*," Milne-Edw.) through which the network of blood-vessels of the outer mantle is connected with the principal blood-system of the Tunicata, the chamberless cardiac tube.

The inner mantle, or dermo-muscular sac, of the Tunicata consists of a transparent porous and fibrous substance, formed by the coalescence of the stellate cells. In this layer are the muscular bundles and the variously intercrossing fibres of the connective tissue. On the side towards the branchial sac\*, and on that towards the outer mantle, this layer is covered with pavement epithelium. The whole inner mantle is developed, as has been proved (by A. Kowalevsky, Kupfer, and others), from the cells of the upper germ-lamella, and consequently, as regards its mode of formation, corresponds to the epidermoidal coverings of all other animals.

#### IV. *The Blood-vascular System.*

The exact investigation of the blood-vascular system in the simple *Ascidia* (*Ascidia intestinalis*, *canina*, *mammillata*) and the *Salpæ* (*Salpa maxima*, *fusiformis*, *pinnata*, *bicaudata*) has proved to me that the blood of these animals circulates in a system of closed vessels. It is possible that it is only the small size of many compound *Ascidie*, *Pyrosomata*, *Cyclo-myariæ*, and *Appendiculariæ* that has prevented the detection of similar vessels furnished with walls in these animals also†. The walls of the vessels consist of a single layer of flat rhomboidal cells. The results obtained by me with regard to the distribution of the blood-vascular system in the inner mantle, in the branchial sac, and in many other parts of the body, agree perfectly with the investigations made by Milne-Edwards‡ and N. Wagner§ on this matter. Among the

\* In all the Tunicata investigated by me I have found on the inner mantle, besides the external adherent epithelial layer, a second such layer on the side towards the branchial sac. See Leuck. Zool. Unters. Heft ii. p. 13.

† The very general belief in the lacunar system of the Tunicata (Gegenbaur, Vergl. Anat. 2te Aufl. pp. 243, 244) does not seem to be satisfactorily supported by facts. Payen's opinion (*loc. cit.* p. 283) that the vascular system is atrophied in the adult *Pyrosomata* is not supported by my investigations, as the main vessels, at least, are always furnished with walls.

‡ Mém. de l'Acad. de Paris, tome xviii. Règne Anim. Mollusques, 1842.

§ Mém. biol. de l'Acad. de St. Pétersb. tome vi. 1866, p. 11 *et seq.*

subsidiary organs belonging to the sanguiferous system I reckon:—*a*, the “band-like organs” (*streifenförmige Organe*\*), most frequently to be met with in *Salpa pinnata*; and *b*, the paired, spherical bodies (“*ovaire*,” Sav.†) of the *Pyrosomata*, which lie in the inner mantle, between the ganglion and the endostyle, on both sides of the body. These organs originate, I believe, from a thickening of many united blood-vessels. They consist of thin epithelial walls; and their cavity is always occupied by free bluish corpuscles, very like the blood-spherules of the Tunicata, and the protoplasm of which is very contractile‡. In the embryos of *Salpa pinnata*, the “band-like organs” appear very late, at first as undefined aggregates of contractile bodies, which afterwards become converted into elongated cylindrical, “band-like organs.” Their number in the nurse-form of *Salpa pinnata* is five on each side; in the chain-*Salpe* there is only one such organ on each side. Their function remains unknown to me.

#### V. The Digestive Organs.

The digestive organs of the Tunicata may be divided into:—the true alimentary canal, which consists of a short œsophagus, a simple or double stomach, an intestine, and a rectum with the anus; and the glandular subsidiary organs—the ciliated arch and more or less separated masses of hepatic cells, which sometimes possess a proper efferent duct, opening into the lower part of the stomach (in some *Cyclomyaria*).

The histological structure of all these digestive organs is very uniform. They consist of:—1, a more or less thin serous membrane, into which looped blood-vessels (*e.g.* in the simple *Ascidia*) and nerves penetrate; 2, a one-layered inner epithelial envelope, the glandular and frequently vibratile cells of which are arranged upon its smooth or much-folded inner surface. The absorption of the alimentary material takes place directly through the thin walls of the blood-vessels. The Tunicata do not possess any special lymphatic vascular system. The tubes formerly designated as lymphatic vessels by Huxley§ are simple glands (“*pancreas*” of other authors?), which open at the surface of the mucous membrane of the intestinal canal and stomach (simple *Ascidia*, *Salpe*).

\* Leuckart, Zool. Unters. Heft ii. pp. 45, 46, Taf. I. fig. 2; Carus, Ic. Zoot. Taf. 18. figs. 33, 34g.

† Mém. sur les Anim. sans Vert. partie 2, pl. xxii. fig. 1.

‡ When the “band-like organs” are isolated and in a fresh state, these corpuscles push forth long pseudopodia, and move very quickly, like the white blood-globules of the higher animals.

§ Phil. Trans. 1851, pp. 570 & 711, pl. xv. fig. 6.

Among the subsidiary organs of the alimentary apparatus I reckon also an enigmatical glandular organ, detected by me in some simple (*Ascidia intestinalis*, *canina*, *Cynthia microcosmus*) and social (*Clavellina lepadiformis*) *Ascidia*. This sac-like gland, consisting of two coalescent portions, is situated sometimes *beneath*\*, sometimes *above*† the central ganglion. It consists of numerous, very variously bent, caecal tubes, lying within a common envelope. Their cavities, which are lined with simple cylinder-epithelium, contain spherical bodies of various sizes. All the tubes of each half of the gland unite in its centre to form a more or less thick tube, or an efferent duct, which opens into one of the nearest cavities of the ciliated pit. This gland occurs very early in young *Ascidia*; but I have not succeeded in ascertaining from which germ-lamella, or from the parts of which organ, it is formed (by eversion?).

The Tunicata are not Mollusca. Even without taking into consideration the mode of embryonal development, a comparison of the plan of structure of the different Mollusca with that of the Tunicata suffices to refer the latter with more propriety to the Vermes. The simple cardiac tube, the absence of the œsophageal ganglia and their commissure, the complete absence of the foot, the curvatures of the intestinal canal directed towards the heart, the existence of the outer mantle, and the peculiarities of its structure, mode of formation, and chemical constitution, the variability in the directions of the contractions of the cardiac tube, &c., all draw a more or less sharp boundary-line between the Tunicata and the Mollusca. The Tunicata approach most closely to the Bryozoa‡.

On the other hand, it must be admitted that the simplicity in the structure of the nervous system (the *Appendiculariæ* excepted) and the cardiac tube, the relation of the respiratory organ to the upper part of the intestinal canal (*Balanoglossus*), the indistinct separation of the inner mantle from the muscular layer (dermo-muscular layer), and the very general alternation of generations, constitute characters by which the Tunicata in some degree approach the type of Vermes§ (to which, thanks

\* In *Ascidia intestinalis* and *canina* and *Clavellina lepadiformis*.

† In *Cynthia microcosmus*.

‡ Huxley, Lect. on Comp. Anat. pp. 80, 85; Hæckel, Gen. Morphol. Bd. ii. p. ciii; Allman, Brit. Assoc. Rep. 1850, and Trans. Roy. Irish Acad. vol. xx. 1852, p. 275; Van Beneden, Mém. Acad. Belg. vol. xx. pp. 54-58.

§ Gegenbaur, Vergl. Anat. 2te Aufl. p. 128; Hæckel, Natürl. Schöpfungsgesch. 4te Aufl. pp. 448, 466, 467.

to careful investigations, the class of the Bryozoa\* is now also referred).

Further, the type of development of the central nervous system, the axial cord or (the *chorda dorsalis* present in many species, the relation of the alimentary tube to the branchial sac (*Amphioxus*), are all exceedingly exact, repeatedly confirmed, and extremely important facts, indicating that the class Tunicata presents the fundamental form from which has been developed the type of the Vertebrata†, hitherto standing isolated in the systems of the animal kingdom.

The entire absence of remains of Tunicata in all geological formations will probably for ever prevent our knowing the transition-forms which united the different kinds of Tunicata with the lowest Vertebrata (*Amphioxus*).

Considering all that has been said, I give Oscar Schmidt's‡ view, according to which the Tunicata form a special class of *Protovertebrata*, the preference over all other opinions.

XLII.—On new Carboniferous Polyzoa. By Professor JOHN YOUNG, M.D., and Mr. JOHN YOUNG, Hunterian Museum, University of Glasgow.

[Plates IX. & IX. bis.]

IN the number of the 'Annals and Magazine of Natural History' for May 1874 we described the structure of the Polyzoon which was named *Millepora gracilis* by Phillips, *Ceriopora gracilis* (Phillips's species), Morris's Catalogue, *Vincularia gracilis* by others; and we showed that the structure was such as to justify the institution of a new genus. We have now examined *Ceriopora rhombifera*, Phillips, and have detected a central axis in it also, this structure being absent in *C. similis* and *C. interporosa*, Phillips. In the two latter species the cells terminate in a mass of cancellated calcareous tissue of varying amount, but never forming a columnar, far less a tubular axis. We prefer therefore to leave them in the genus *Ceriopora*, transferring *C. rhombifera* to our new genus *Rhabdomeson*. After the publication of our former

\* Chiefly on the basis of the remarkable investigations of Nitsche on *Alcyonella fungosa*, Pall. See also Mém. Acad. St. Pétersb. vol. xv. p. 50.

† With respect to this, see Hæckel, Gen. Morphol. Bd. ii. p. cxvi et seq., and p. 413 et seq.

‡ Vergl. Anat. 6te Aufl. 1872, p. 248. See also Hæckel, Natürl. Schöpfungsgesch. 4te Aufl. pp. 466, 467, Taf. 12, 13.

paper we sent to Professor Phillips specimens of *Rh. gracile*, and received in reply the following note, among the last which he wrote:—

“April 3, 1874.

“MY DEAR SIR,—I agree with you in referring your beautiful specimens to the three species (*M. gracilis*, *M. rhombifera*, *M. interporosa*) named in my books (‘Yorkshire,’ vol. ii., and ‘Palaeozoic Fossils’). Your examples are better than mine were; but I have no doubt of the reference. The axis, which is jointed in your specimens, has probably been examined (small as it is) in transverse sections. The difference of opposite faces in *C.* or *Rh. rhombifera* is very interesting. . . .

“Yours truly,  
“JOHN PHILLIPS.”

The appearance of jointing is fallacious, as Prof. Prestwich may ascertain, the specimens having been retained by Prof. Phillips for the Oxford Museum.

#### RHABDOMESON, Young and Young, 1874.

##### *Rhabdomeson rhombiferum*, Phillips's species.

##### *Ceriopora rhombifera*, Phillips.

Stems slender, cylindrical, free; branches of nearly equal diameter, given off at wide intervals, as in *Rh. gracile*, and at right angles to the stem. Cells in quincunx all round the stem; they open at the bottom of depressed areas which are rhomboidal or hexagonal in outline and are bounded by narrow tuberculated ridges, the tubercles on which are larger at the angles of junction; average number of tubercles round each area, sixteen. Here and there depressed pits with quadrangular boundaries intervene between adjacent cell-areas; but they are caecal, and do not show in transverse sections. Cell-areas more numerous on one face than on the other, in the proportion of 2 to 3, the size of the areas being inverse to their number. Central axis slender, slightly flexuous, and without transverse septa. Cells conical, tapering inferiorly; their casts identical in form with those of *Rh. gracile* (Ann. & Mag. Nat. Hist. 1874, xiii. pl. xvi. b. figs. 3 & 4).

*Locality*.—Hairmyres, East Kilbride, in limestone shales, and sparingly in every bed which yields *Rh. gracile*.

This species is easily distinguished from *Rh. gracile*: 1, its stem is only half the thickness; 2, the cell-areas are larger and angular; 3, the prominent angular tubercle is wanting;



4, the cell-areas are of unequal size and number on the two faces.

In Plate IX. the two faces are shown, and a transverse section exhibiting the proportions of the central axis. The specimens are in the Hunterian Museum.

In the Explanation of Sheet 23 (Mem. Geol. Survey Scotland) Mr. R. Etheridge, Jun., refers (p. 102) to "a species of *Polypora*, bearing a considerable resemblance to *P. verrucosa*, M'Coy. The portions obtained are fragments of a robust branching coralline, with a nearly circular section, and a generally strong and thick appearance, covered with numerous cell-apertures arranged in alternating lines on the celluliferous aspect, five or six apertures in each oblique line. The cells are very pustulose or wart-like, with prominent raised margins. The interspace between each aperture is occupied by waving striae, and in some few specimens appears roughened. In *P. verrucosa*, M'Coy, the apertures are round, in the present species they are oval; the margins are equal all round, here one is more projecting than the other. It has also a more robust and stronger appearance than M'Coy's species. The reverse presents the peculiar roughened look previously noticed. As it has only, hitherto, been found in fragments, the general habit and nature of the dissepiments cannot be stated. The disposition of the cells and mode of branching are exceedingly like those seen in *Thamniscus dubius*, Schl. (King, Perm. Foss. p. 45, pl. v. fig. 9). In the generic description of *Polypora*, M'Coy (Synopsis Carb. Foss. p. 206) states that the margins of the cell-apertures are never raised. As the margins in the present form are decidedly raised and prominent, might it not be a species of *Thamniscus*? If it be a new species of *Polypora*, I would propose for it the specific designation of *P. pustulata*."

We have received from Dr. Rankin, of Carlisle, specimens of the fossil in question, so well preserved and showing the habit so clearly that we are enabled to give the following description.

*Thamniscus? Rankini*, sp. nov. Plate IX. bis.

Stems free, dichotomous, circular, about  $\frac{1}{18}$  inch in diameter; branches in one plane. Celluliferous face equal to two thirds of circumference. Cells arranged in spirals, the left-handed series longer than the right-handed. Cell-apertures circular when entire, becoming oval when worn; lower lip prominent;

margins of aperture tuberculate. Intercellular surface covered with finely tubercular ridges, whose terminations form the marginal denticles. Non-celluliferous aspect finely granular, faintly striate. Cells encroach irregularly on this face (Plate IX. *bis*, fig. 5); and small apertures (fig. 4) seem to represent aborted cells.

*Locality*.—Gillfoot, Carluke; Gair; Robroyston: in Upper Limestone shales.

The ornament of a very young branch (fig. 6) has a curious resemblance to that of *Sulcoretipora*. Figure 7 shows one of the apertures at the margin of the non-celluliferous aspect, and the wavy striae around it.

The generic position of the fossil is uncertain. It is not a *Polypora*, since it is not reticulate. *Thamniscus*, King, shows a tendency to reticulation; but the junctions are at small angles. *Synocladia* presents the next step towards the *Fenestella* type. If the gemmuliferous vesicles described by King are essential to his *Thamniscus*, this character is wanting in our species, even in the best-preserved specimens. Longitudinal sections show the cells starting from an imaginary axis, and reaching the surface at various levels; but the tendency to an arrangement in transverse series, seen in fig. 2, is apparent. We have not yet found the base of attachment. Meanwhile, though strongly disposed to regard this fossil as a true *Hornera* or a member of a closely allied genus, we think it safer to leave it in the Palaeozoic genus *Thamniscus*, and to name it *Th.? Rankini*, after the gentleman to whom we owe the finest examples.

XLIII.—*Note on the Geographical Distribution of the Temnocephala chilensis of Blanchard.* By JAMES WOOD MASON, Professor of Comparative Anatomy, Medical College, Calcutta.

SOME months ago I received from Captain F. W. Hutton, Curator of the Otago Museum, Dunedin, New Zealand, a series of specimens of the freshwater crayfish lately described by him in this Journal under the name of *Puranephrops setosus*, and was astonished to find, in the sediment at the bottom of the jar containing these crustaceans, numerous examples of this remarkable little Trematode (which owes its generic name to the fact that the cephalic end of its body is divided by four fissures into five tentacular processes, and

which is always found living ectoparasitically on the bodies of freshwater crustaceans); but none of them being still adherent to the integument of their "chum," and it consequently appearing to me just possible that they might have been detached from some other animal previously received from Chili in the same jar, I deemed it the wiser course to wait for more conclusive evidence of so interesting a distributional fact.

I have since received from my friend Mr. W. Guyes Brittan, of Christchurch, New Zealand, an abundant supply of each of two species of crayfish, from the rivers Avon and Waimakiriri respectively, two or three individuals of each of which have great numbers of this Trematode still affixed to the smooth intervals between the spines, both of the carapace and of the chelipeds. The occurrence of *Temnocephala* in New Zealand is thus established.

In their present shrunken condition, the little creatures closely resemble a split pea, with the tentacles projecting, fringe-like, from a portion of the circumference, and range from 1 to 4 or 5 millims. in diameter.

Dr. R. A. Philippi, who gives (in 'Archiv für Naturgesch.' 1870, vol. xxxvi. pp. 35-40, pl. i. figs. 1-6) some details of its structure, states that he himself found it in Chili on a species of *Eglea*, and on no other river-prawn. Dr. C. Semper, who met with it in the Philippines on various species of freshwater crabs, in an interesting and full account (in 'Zeitschr. für wiss. Zool.' 1872, vol. xxi. pp. 307-310, pl. xxiii.) of its anatomical structure, shows conclusively that its true position is amongst the Trematodes, and not amongst the Leeches, as was supposed by Blanchard and Moquin-Tandon.

Calcutta, March 5, 1875.

P.S.—Since the above was written, I have received the zoological collections made by Major Godwin-Austen during the expedition against the Daflas (as certain of the wild Mongoloid inhabitants of the north-east frontier of India are called), and found a single specimen of *Temnocephala chilensis* in a bottle containing, besides numerous land animals of various groups, two fishes, to one of which it had in all probability been attached.

Indian Museum, Calcutta,  
March 19, 1875.

XLIV.—*Descriptions of new Species of Lepidoptera from Central America.* By ARTHUR GARDINER BUTLER, F.L.S., F.Z.S., &c.

WE received some time since a species of *Morpho*, which I have been unable to identify with any form hitherto characterized. It is a very distinct and beautiful species, resembling on the upperside, as also in the outline of the wings, *M. Montezuma* and allies; on the underside, however, it more nearly approaches *M. Neoptolemus*. As I believe this species to be quite new, I characterize it as follows:—

*Morpho polybaptus*, n. sp.

Above very like *M. Montezuma*: wings greenish blue, with a moderately broad black outer border: primaries with basicostal area dusky; a white spot above end of cell; black border widest upon costa, which is also black as far as the white spot; an oblique elongate subcostal white spot at inner third of external black border, also *two apical submarginal series of white points*, the inner series of four, the outer of three points; fringe spotted with white at extremity of internervular folds: secondaries with the outer black border rather narrower than in primaries; fringe with two white spots between each undulation; two dull red lituræ at anal angle; abdominal area grey, palest at base: body dull brown; head, collar, and pterygodes black; the external margin of the palpi and two dots between the eyes red, two spots on the collar creamy yellow, a spot on each of the pterygodes greyish white; antennæ black. Wings below deep chocolate-brown, varied with pale shining green bands, large red-zoned ocelli, and buff and scarlet submarginal bands: general pattern as in *M. Neoptolemus*, from which it differs as follows:—primaries with the costal greenish streak red at base; no longitudinal green streaks in the cell, but two well-defined transverse streaks—the first irregular, oblique, reddish at its lower extremity, the second crossing the middle of the cell in a straight line; two indistinct, irregular, oblique, subterminal discoidal lines; streaks bounding the lower margin of the cell and the bases of the median branches, rose-coloured instead of green; irregular postmedian green band distinct, and nearly equal in width from subcostal nervure to the middle of interno-median interspace, where it terminates near the external angle in two rosy spots; an oval oblique subcostal spot above the uppermost ocellus; ocelli with narrower deep orange-red zones; sub-

marginal white spots wider apart, connected by distinct black dashes, the ground-colour between them bright buff; secondaries with a crimson streak near the base and three on abdominal area, also a crimson streak along the lower half of the abdominal margin; irregular green streaks on basal area broader and more distinct; intermediate submarginal lunulated streak crimson, excepting at the interruptions on the nervures, where it is grey; ocelli larger, with deep orange-red zones.

Expanse of wings 5 inches 3 lines.

*Hab.* Costa Rica (*Grab*). Type, B.M.

In a collection of insects recently presented to the British Museum by Osbert Salvin, Esq., I have found the following beautiful new species of Heterocerous Lepidoptera:—

### Family Arctiidæ.

#### Subfamily CHARIDEINÆ\*.

#### Genus BELEMNIA.

#### *Belemnia Jovis*, n. sp.

General character of *B. eryx*, but much larger and more brilliant in colouring, the rosy spot on primaries replaced by a larger deep-carmine spot; the abdomen above entirely bright metallic green, with a central longitudinal brown streak; in *B. eryx* the hinder segments are purple in the male, and the female probably has a yellow instead of a rosy spot in primaries; on the underside the green streaks and spots are much more brilliant than in *B. eryx*, and the carmine spot as above.

Expanse of wings 2 inches to 2 inches 1 line.

*Hab.* Veragua (*Salvin*), Honduras (*Miller*). Type, B.M.

The example from Honduras was previously the only representative of this species in the collection, and was considered to be the female of *B. eryx*; now, however, we have a fine series, owing to the generosity of Mr. Salvin, and there can be no doubt of its entire distinctness. It is most like *B. inaurata* of Sulzer (nec Cramer), but differs in the uniform green colour of the abdomen in both sexes. *B. inaurata* of Cramer may be named *B. Crameri*.

\* I find by a careful study of the structural characters of this group, and more especially of the neuration of the wings, that they cannot be separated from the Arctiidæ.

Subfamily *PERICOPINÆ*.Genus *PERICOPIS*.*Pericopis Lucretia*, n. sp.

♀. Allied to *P. zerbina*, but broader and shorter in the wing; the bands in primaries less oblique and more diffused; the spot crossing the discoidal cell narrowed into a streak, and continued across the wing to the submedian nervure; the submarginal series of reddish ochreous lunulated spots smaller, eight in number, and therefore forming a continuous series; the discocellular black line interrupted; abdomen more orange in tint; primaries below with all the markings well defined, the median nervure and its branches blackened; secondaries with the veins blackened, the costal area (excepting at base) dark brown; the outer margin with a broad dark brown border; the submarginal ochreous spots seven in number, and very small; a broad black longitudinal ventral streak on the abdomen.

Expanse of wings 2 inches 10 lines.

*Hab.* Veragua (*Salvin*). Type, B.M.

The position of this species will be between *P. leonina* and *P. zerbina*.

Family *Melameridæ*.Genus *JOSIA*.*Josia cruciata*, n. sp.

Primaries black, with a broad orange-yellow streak from base to centre of outer margin; secondaries with the costa and external areas broadly black, a broad central orange-yellow belt from inner margin to apex; inner margin orange; body black above, head and thorax spotted with orange, metathorax orange; abdomen with a creamy white, narrow lateral line: trochanters, proximal extremity of tibiæ and tarsi of first pair of legs, whole of hind pair of legs, creamy white; venter creamy white; body below otherwise black; wings with the orange bands broader, otherwise as above.

Expanse of wings 1 inch 3 to 5 lines.

*Hab.* Veragua (*Salvin*). Type, B.M.

Nearly allied to the *Josia fulvia* of Walker and to *J. ligata*, but easily distinguished from both by the whitish lateral line and more distinctly white venter of the abdomen; it also differs from the *Josia fulvia* of Walker (nec Linn.) in the greater width of the orange bands, and from both in the

absence of an orange costal margin to the primaries. The *Phalœna fulvia* of Clerck's 'Icones' is a *Chrysaugæ* closely allied to my *C. limbata*.

Family **Lithosiidæ**.

Genus **RUSCINO**.

*Ruscino latifasciatus*, n. sp.

Closely allied to *R. menea*, but rather smaller, with the ochreous bands of primaries, basal area of secondaries, and body deeper in colour, the bands of primaries broader, the external black area of secondaries slightly narrower.

Expanse of wings 1 inch 4 to 8 lines.

*Hab.* Veragua (*Salvin*). Three specimens, B.M.

Evidently a local form of *R. menea*.

Family **Larentiidæ**.

Genus **SCORDYLIA**.

*Scordylia Salvini*, n. sp.

Wings above saffron-yellow, the apices broadly black; primaries with the outer margin, including the apical area, from centre of costa to submedian nervure broadly (but decreasingly) black, the inner edge of the black area irregularly zigzag, internal margin at external angle narrowly black, three basicostal red-brown dots: a small quadrate costal yellow spot at centre of black apical area; two or three apical whitish dots on the fringe; secondaries with the apical black area tri-undulated internally; an irregular narrow external black border from apical area to anal angle: body whity brown: primaries below with the basal half of costa whity brown, crossed by black and red-brown liture; apex red-brown; the costal spot and a diffused patch at apex whity brown; secondaries whity brown, freckled with red-brown; apical area red-brown, varied with grey and whity brown; otherwise as above.

Expanse of wings 1 inch 4 lines.

*Hab.* Veragua (*Salvin*). Two examples, B.M.

*S. Salvini* is most nearly allied to *S. perfectaria*, but is larger, has the black area of primaries much narrower towards external angle, and a yellow costal spot upon it; the apical area of secondaries is also broader, and the under surface of all the wings (excepting at apex of primaries) much deeper in colour.

## Family Tortricidæ.

## Genus ATTERIA.

*Atteria rivularis*, n. sp.

Nearly allied to *A. volcanica*; rather more golden in colouring, the black costal area of primaries broader, and the external border narrower; the transverse creamy-white streaks of costal area longer, and not united to one another at their lower extremities; the branching apical external streaks more transverse; five black spots within the lower half of the cell, one or two on the disk near the external margin, and sometimes several along the inner margin; secondaries with three disconnected marginal black spots at apex, and five along the external margin: below as above.

Expanse of wings 1 inch 3 lines.

*Hab.* Veragua (*Salvin*). Two specimens, B.M.

This species evidently takes the place of the New-Granadan *A. volcanica* at Veragua; it is a very beautiful insect.

Amongst the other Lepidoptera presented to the collection by Mr. Salvin, I may mention the very beautiful *Charidea arrogans* of Walker, *Flavinia lata*, and *Simena luctifera*, of which we previously only possessed the types (of *C. arrogans* four examples, and of the other two species a good series); also two examples of *Tosiomorpha longivitta*, Felder, which was not previously in the collection, but only differs in its superior size from Walker's *Josia penetrata*.

XLV.—*Tylenchus millefolii*, n. sp., a new Gall-producing  
*Anguillulide*. By Dr. FRANZ LÖW\*.

ON the lowest leaves of the common milfoil (*Achillea millefolium*, Linn.), which usually form a small turf, from spring to autumn we find small gall-like inflations, 3-4 millims. in length, which are generally seated upon the midrib, less frequently at the base of the pinnae, but always in the neighbourhood of the apex of the leaf. These inflations, which show no means of entrance or exit any where, are covered externally by the epidermis of the leaf, and are at first just as green as the rest of the leaf and equally hairy. The walls

\* Translated by W. S. Dallas, F.L.S., from the 'Verhandlungen der k.-k. zoologisch-botanischen Gesellschaft in Wien,' Band xxiv. (1874), pp. 17-24.



are at first comparatively thick, firm, and full of sap; but towards autumn they gradually become thinner, less juicy, and wrinkled in folds, whilst their colour at the same time gradually changes to yellowish green. Two or three of these galls often occur upon one leaf, by which the latter is greatly deformed, as each gall causes an angular bending or twisting of the axis of the leaf.

If we open one of these inflations we see in its interior, with the lens, a soft whitish lump, surrounded and penetrated by a greenish yellow, somewhat viscous fluid. This whitish lump, when brought into contact with a drop of water, quickly flows asunder; and we then see, under the microscope, hundreds of *Anguillulæ* in all stages of development, twisting about one over the other with slow movements.

As in all known *Anguillulæ* of plants, the extraordinary vitality of this species after desiccation for months is very remarkable. I tested this tenacity of life, by taking a leaf bearing galls, collected in May and dried for my herbarium, and moistening it in October. Within a few hours all the *Anguillulæ*, which had been dried in it until they were quite brittle, were again lively. Even those which are repeatedly dried upon the object-slide of the microscope waken to new life after each moistening. This remarkable tenacity of life is confirmed by most authors. Dr. Julius Kühn, who discovered *Anguillula dipsaci* in the inflorescence and fruit of *Dipsacus fullonum*, Mill.\*, found that this species came to life again when moistened with water after eight months' desiccation in a heated room. Bauer† states the duration of the capacity of revivification in *Anguillula tritici* at eight years. Baker‡ found that the young of *Anguillula tritici* enclosed in diseased grains of wheat could be revived even after a desiccation of twenty-seven years, by moistening with water; and this property, which the *Anguillulæ* possess in common with the Tardigrada and Rotatoria, was already known to Linné§.

But reviving as is the effect of moistening with water upon the dried *Anguillulæ*, remaining in it is equally injurious to them; for although they cannot exist without a certain amount of moisture, they die in water usually within a few days, as

\* Zeitschr. für wiss. Zool. Bd. ix. (1858), p. 129.

† Ann. des Sci. Nat. tome ii. (1824), p. 154.

‡ Lettre de Needham en réponse au Mémoire de Roffredi dans le Journal de Physique de l'Abbé Rozier, 1775, p. 227.

§ Linné says of the *Anguillulæ* of vinegar and paste (Syst. Nat. ed. xii. tom. i. p. 1326):—"Chaos: Corpus liberum, uniforme, redivivum, artubus sensusque externis nullis. 1. *Ch. redivivum*, filiforme, utrinque attenuatum; habitat in aceto et glutine Bibliopegorum. Reviviscit ex aqua per annos exsiccatum; oviparum vel viviparum."

was also observed by Dr. Kühn in the case of *Anguillula dipsaci*.

I have hitherto met with the deformations produced by the Anguillulide under consideration on the leaves of *Achillea millefolium*, only in some parts of the Pfalzauenthal in the Wienerwald, and always only in very small numbers. Whether the whole plant is injured by it I could not ascertain, as I have always found it only upon the leaves of isolated plants of scanty growth standing upon poor soil, never upon strong and luxuriant plants.

The Anguillulæ themselves agree exactly in their principal characters with the other known forms infesting plants. The only specific differences are derived from the size and colour of the body, and the proportions of its parts to one another. But before indicating the specific characters of the milfoil-Anguillula, I will give an accurate description of it.

The Anguillulæ of the milfoil have an elongated body, attenuated towards the two ends, round in transverse section, and of undecided colour. They may be said to be translucent whitish with a greenish yellow shimmer. This shimmer, however, appears to proceed from their food, which in all probability consists of the above-mentioned greenish yellow fluid contained in the galls. By transmitted light the body is seen to be entirely filled with granules of different sizes and forms, which prevent any examination of internal organization. The external integument of the body is rather thick, quite smooth, and shining. In the middle of the anterior, obtusely rounded end of the body is the mouth, which is continued within into the œsophagus, which runs straight for a very short distance, and at a distance from the mouth equal to the transverse diameter of the body at the same spot presents a globular muscular dilatation. From this it runs backward in an indistinctly visible tortuous line, and at the second curvature loses itself entirely in the granular contents of the body. In *Anguillula dipsaci* Dr. Kühn observed that the portion of the œsophagus situated behind the globular dilatation was also somewhat tortuous, and presented at its extremity a second similar dilatation, which I could not detect in the Anguillula of the milfoil. The other Anguillulidæ (e. g. *A. fluviatilis*, *aceti*, *glutinis*, *mucronata*, *linea*, &c.) possess similar rounded muscular dilatations of the œsophagus\*.

The posterior extremity of the body is rather rapidly attenuated, and terminates in a much finer point than the anterior end. Prof. Grube has already indicated that all Anguillulæ

\* Grube, "Ueber einige Anguillulen, und die Entwicklung von *Gordius aquaticus*," in Arch. für Naturg. Jahrg. xv. (1849), p. 358.

living in plants are oviparous\*, and that they have their genital apertures in the vicinity of the posterior extremity of the body. This is precisely the case in the *Anguillula* of the milfoil; it is oviparous, and the genital apertures of both sexes are more or less near the caudal extremity. Their distance from the latter must be regarded, in the present state of our knowledge of these animals, as one of the best of the few specific characters. The male has a somewhat curved linguliform penis, rapidly attenuated from a broad base; this can be pushed forth from the anus, which surrounds it like a sheath, and opens obliquely backwards and outwards. The cleft-like anal orifice, which is placed transversely to the longitudinal axis of the body, has a slightly prominent margin, and is situated at a distance of one sixteenth or one seventeenth of the total length of the body from the end of the tail. Immediately behind the anus the transverse diameter of the body of the male diminishes considerably; it tapers off quickly to a point, which in the adult male is always bent almost angularly in a direction away from the anal aperture. In most cases the penis was retracted within the anus, so that the margins of the latter closed together; only in one individual did the apex of the penis project from the anal cleft, when it was distinctly seen to be a little broader than thick, *i. e.* tongue-shaped. The magnifying-power with which I worked did not enable me to see distinctly the two *spicula* and accessory parts, of which the penis of the *Anguillulidæ* consists.

A short distance in front of the male genital aperture, about the beginning of the last twelfth of the body, there originates a very delicate, perfectly transparent membrane, which extends over the above-mentioned genitalia to the hinder extremity, and is attached to the sides of the body. This membrane is usually tightly stretched, only appearing slightly folded transversely in dried individuals. When the male is laid exactly on his back, the membrane described is frequently seen to project a little laterally beyond the margin of the body; but in most instances this is not the case.

\* As Linné was already aware (see note §, p. 343), the *Anguillulidæ* are sometimes oviparous, sometimes viviparous. These different modes of reproduction even occur in the same species; for Goeze reports ("Mikrosk. Erfahrungen über die E-sigale," in the 'Naturforscher,' Stück i. 1774, p. 34) that the *Anguillula* of vinegar bear living young after the manner of the Aphides, from July until autumn, and in the autumn lay eggs which survive the winter. Nay, even the same individual may be both oviparous and viviparous; for Claus states (*Zeitschr. für wiss. Zool.* Bd. xii. 1863, p. 354) that his oviparous *A. brevispina* is identical with Grube's *A. mucronata*, as in this species the same female produces her first brood oviparously and the later ones viviparously.

What functions this organ performs, and what are its relations to the genital organs, is still unknown. Dr. J. Kühn first discovered this organ in the male of his *Anguillula dipsaci*, and he also found it impossible to find any data for its elucidation in his repeated observations of that worm. With regard to the interpretation of this organ (which occurs in the males of all the species of the genera *Tylenchus*, Bast., and *Rhabditis*, Duj.) I agree rather with Kühn than with Bastian\*, being, like the former, of opinion that it is stretched like a velum over the anal aperture; whilst Bastian thinks that two delicately membranous wings ("caudal alæ") are attached to the sides of the tail of the male, the contour of which is seen under the microscope both in the lateral and dorsal position. For if Bastian's opinion were correct, the membrane must appear much narrower in the lateral than in the dorsal position of the animal; but just the contrary is the case.

The female genital aperture is also situated near the hinder extremity of the body, and leads to a vagina directed vertically to the longitudinal axis of the body, which opens outwards with prominent margins, and there appears as a short transverse cleft (*vulva*). The distance of the vulva from the hindmost point is one eighth of the total length of the body. This [caudal] part of the body in the female is always slightly bent towards the ventral side, and does not diminish so rapidly as in the male. As already mentioned, the granular and vesicular contents of the body render all inspection of it almost impossible; and so I did not succeed in recognizing the internal sexual organs, the termination of the intestine, and the anal aperture in the female; on the other hand, I twice saw distinctly, in the interior of the body of the female, quite close to the vulva, a sharply defined egg, which showed precisely the same finely granular contents mixed with a few vesicles as the numerous eggs lying loose among the worms.

Males and females do not differ in length in this species. The greater number of them are almost exactly 1 millim. in length; only a few do not reach this size, and remain only 0·9 millim. long. But as exceptions exist almost everywhere, I found among the majority of females of nearly equal length one of 1·3 millim. length, and of proportionately increased thickness. As regards thickness, the males of the same length appear to be a little thinner than the females. It is, however, very difficult to give perfectly accurate, reliable measurements for creatures such as these little worms—as on the one hand, when alive they are never still, but are constantly bending, stretching

\* "Monograph on the Anguillulidæ," Trans. Linn. Soc. vol. xxv. (1866). p. 125.

and pushing about; and on the other, when dead, although they may lie straight, they may always be unduly extended or contracted, which with such small individuals may easily cause a difference of 0·1 millim. or even more. The young Anguillulae not yet sexually mature, which always occur associated with the fully developed and sexually mature individuals, and indeed in greater number than the latter, are of very different lengths according to the degree of their development. In the form of the body they resemble the sexually mature individuals; only the granules and vesicles of the contents of the body are larger.

The egg is about twice as long as broad, equally rounded at the two ends; its contents are finely granular, with several vesicles scattered through them. Some time before hatching, the young Anguillulae may be seen through the delicate membrane of the egg. They lie elliptically curled up in the egg, following the form of the latter. When hatched they are about five times as long as the egg, or about one fifth of the length of the adult\*. The circumstance that we almost always find together all the stages of development of the Anguillula of the milfoil, from the egg to the egg-laying individual, may be explained by supposing either that in this species several generations follow one another during the favourable season of the year, or that the oviposition takes place at very various times, as, indeed, Dr. Kühn supposes to be the case with *Anguillula dipsaci*.

The mode of life of the milfoil-Anguillula probably resembles exactly that of *A. dipsaci*, Kühn, *A. tritici*, Roff., and other Anguillulae of plants. The young asexual Anguillulae winter in the leaf-galls; or the last-deposited eggs may winter outside the galls; and in the spring, when the galls are already rotted by the moisture of the soil, they quit them, creep upon the young shoots of the milfoil, bore into the still tender tissues of the expanding leaves, and produce upon them afresh the galls described at the commencement of this paper, in which they become further developed, and give birth to new generations. Towards autumn the original abundance of sap in the galls is gradually exhausted, their green colour passes to yellow; finally they become withered and wrinkled; and the individuals contained in them, which have never quitted the gall, stiffen or become dried up at the beginning of the cold season, to be awakened again from this apparent death only by the sunshine of spring.

\* In the viviparous Anguillulidae, such as *Anguillula acetii*, *glutinis*, *aviciatilis*, &c., the young are born still enclosed in the egg-membranes.

Bauer, Davaine\*, and Bastian have made interesting observations as to the mode in which the *Anguillulæ* of the wheat get into the flowers of *Triticum vulgare*, Vill. Bauer sowed grains of wheat into the furrows of which he had introduced young individuals of *Anguillula tritici*, and found, by examining the plants from time to time, that the *Anguillulæ* ascended to the ears in the interior of the straw. Davaine, on the contrary, asserts that the *Anguillulæ* creep from without into the innermost sheath of leaves which surrounds the growing ear, and then penetrate into the extremely delicate parenchyma of the flowers at a time when all the parts of the flower exist as rudiments in the form of scales. Bastian, who successfully repeated Bauer's inoculation experiments, confirms Davaine's observations, which also agree with the opinions expressed by Dr. Kühn as to the mode of life of *Anguillula dipsaci*.

The *Anguillula* discovered by me producing galls upon the milfoil belongs to the genus *Tylenchus*, established by Bastian, and characterized by him as follows †:—"Body naked, tapering at the two extremities; extremity of tail without a sucking-papilla; integument with extremely fine transverse striæ; in the pharynx a protrusible spear with a trilobed base; œsophagus globularly dilated in the middle; intestine indistinct, covered with coarse, colourless fat-granules; vulva considerably behind the middle of the body; uterus unsymmetrical; the two *spicula* of the penis united to the posterior accessory piece; caudal alæ in the males not supported by rays; movements sluggish." To this genus Bastian refers, besides three species (*T. Davainii*, *terrivola*, and *obtusus*) established by him, *T. tritici*, Roffredi, of the wheat, *T. dipsaci*, Kühn, of the teasel, and the grass-*Anguillulæ* (*T. agrostidis* and *phalaridis*, Steinb.), which Steinbuch ‡ found in pouch-like galls in the flowers of *Agrostis sylvatica*, Huds., and *Phalaris phleoides*, Linn.§ It is probable that the producers of the galls found by Frauenfeld|| upon the leaves of *Gnaphalium Leontopodium*,

\* Davaine, 'Recherches sur l'Anguillula du blé niellé,' Paris, 1857, pl. iii. fig. 12.

† [Dr. Löw seems to have modified Mr. Bastian's generic character, as this, although marked as a quotation, differs in some points from the description in Linn. Trans. vol. xxv. p. 125.—Ed.]

‡ 'Der Naturforscher,' 28. Stück (1799), pp. 233 & 255. Diesing, in his 'Systema Helminthum,' ii. p. 132, has described as a single species, under the name of *Anguillula graminearum*, the three species *A. tritici*, *agrostidis*, and *phalaridis*.

§ *Agrostis sylvatica*, Huds., is synonymous with *Agrostis polymorpha*, Huds.; and *Phalaris phleoides*, Linn., with *Phleum Böhmeri*, Wibel.

|| 'Verhandl. zool.-bot. Gesellsch. in Wien,' Bd. xxii. p. 397.

Jaeg., and *Fulcaria Rivini*, Host, also belong to this genus, and perhaps the *Anguillula secalis*, Nitschke, which lives in the lower internodes of the rye\*.

Almost all the species placed in this genus live in plants, and are for the most part gall-producers; for, according to Davaine's investigations, the cockled grains of wheat are not diseased seeds, but galls probably originating from the rudiment of a filament, as he found the aborted pistil in the diseased flowers; and Bastian (*l. c.* p. 87) further adduces, in support of this view, the fact that in his inoculation experiments the cockled grains were always formed on the diseased plants when the healthy stalks first began to flower. By analogy the little sacs in the flowers of grasses in which Steinbuch found the above-mentioned grass-*Anguillulæ* will also probably be not deformed fruits, but galls.

As the *Anguillula* of the milfoil differs from the other species of the genus *Tylenchus* by several constant characters, I describe it as a new species under the name of *Tylenchus millefolii*. The following is its diagnosis:—

*Tylenchus millefolii*†, n. sp.

Albidus, transparens, corpore in utroque sexu 0·9–1·3 millim. longo, extremitate antica parum attenuata, obtusa, rotundata, postica lentius acuminata, cauda maris (a pene)  $\frac{1}{16}$ – $\frac{1}{17}$  corporis æquante, dorsum versus hamuli instar curvata, cauda feminae (a vulva)  $\frac{1}{8}$  corporis æquante, ventrem versus paulo incurva. Distantia bulbi œsophagi ab ore latitudinem corporis eodem loco vix æquante.

*Habitaculum*: Gallæ in foliis *Achilleæ millefolii*.

XLVI.—*Experiments on the supposed Auditory Apparatus of the Culex mosquito.* By ALFRED M. MAYER†.

OHM states in his proposition that the ear experiences a simple sound only when it receives a pendulum-vibration, and that it decomposes any other periodic motion of the air into a series of pendulum-vibrations, to each of which corresponds the sensation of a simple sound. Helmholtz, fully persuaded of the truth of this proposition, and seeing its intimate connexion

\* 'Verhandl. zool.-bot. Gesellsch. in Wien,' Bd. xviii. p. 901.

† [The worm is figured, with some details by the author (*l. c.* pl. i. B); but we have not thought it necessary to reproduce the figures, as the description is clear enough without them.—ED.]

‡ From the 'Philosophical Magazine,' ser. 4, vol. xlvi. No. 319.

with the theorem of Fourier, reasoned that there must be a cause for it in the very dynamic constitution of the ear; and the previous discovery by the Marquis of Corti of several thousand\* rods of graded sizes in the ductus cochlearis, indicated to Helmholtz that these were suitable bodies to effect the decomposition of a composite sonorous wave by their covibrating with its simple harmonic elements. This supposed function of the Corti organ gave a rational explanation of the theorem of Ohm, and furnished "a leading-thread" which conducted Helmholtz to the discoveries contained in his renowned work *Die Lehre von den Tonempfindungen*†. In this book he first gave the true explanation of timbre, and revealed the hidden cause of musical harmony, which, since the days of Pythagoras, had remained a mystery to musicians and a problem to philosophers.

It may perhaps never be possible to bring Helmholtz's hypothesis of the mode of audition in the higher vertebrates to the test of direct observation, from the apparent hopelessness of ever being able to experiment on the functions of the parts of the inner ear of mammalia. The cochlea, tunnelled in the hard temporal bone, is necessarily difficult to dissect; and even when a view is obtained of the organ of Corti, its parts are rarely *in situ*, and often they have already had their natural structure altered by the acid with which the bone has been saturated to render it soft enough for dissection and for the cutting of sections for the microscope.

As we descend in the scale of development from the higher vertebrates, we observe the parts of the outer and middle ear disappearing, while at the same time we see the inner ear gradually advancing toward the surface of the head. The external ear, the auditory canal, the tympanic membrane, and with the latter the now useless ossicles, have disappeared in the lower vertebrates, and there remains but a rudimentary labyrinth.

\* According to Waldeyer, there are 6500 inner and 4500 outer pillars in the organ of Corti.

† "But all of the propositions on which we have based the theory of consonance and dissonance rest solely on a minute analysis of the sensations of the ear. This analysis could have been made by any cultivated ear without the aid of theory; but the leading-thread of theory and the employment of appropriate means of observation have facilitated it in an extraordinary degree.

"Above all things I beg the reader to remark that the hypothesis on the covibration of the organs of Corti has no immediate relation with the explanation of consonance and dissonance, which rests solely on the facts of observation, on the beats of harmonics and of resultant sounds."—Helmholtz, *Tonempfindungen*, p. 342.



Although the homological connexions existing between the vertebrates and articulates, even when advocated by naturalists, are certainly admitted to be imperfect, yet we can hardly suppose that the organs of hearing in the articulates will remain stationary or retrograde, but rather that the essential parts of their apparatus of audition, and especially that part which receives the aërial vibrations, will be more exposed than in higher organisms. Indeed the very minuteness of the greater part of the articulates would indicate this; for a tympanic membrane placed in vibratory communication with a modified labyrinth, or even an auditory capsule with an outer flexible covering, would be useless to the greater number of insects, for several reasons. First, such an apparatus, unless occupying a large proportion of the volume of an insect, would not present surface enough for this kind of receptor of vibrations; and secondly, the minuteness of such a membrane would render it impossible to covibrate with those sounds which generally occur in nature, and which the insects themselves can produce. Similarly, all non-aquatic vertebrates have an inner ear formed so as to bring the aërial vibrations which strike the tympanic membrane to bear with the greatest effect on the auditory nerve-filaments; and the minuteness of insects also precludes this condition. Finally, the hard test, characteristic of the articulates, sets aside the idea that they receive the aërial vibrations through the covering of their bodies, like fishes, whose bodies are generally not only larger and far more yielding, but are also immersed in water which transmits vibrations with  $4\frac{1}{4}$  times the velocity of the same pulses in air and with a yet greater increase in intensity. For these reasons I imagine that those articulates which are sensitive to sound and also emit characteristic sounds, will prove to possess receptors of vibrations external to the general surface of their bodies, and that the proportions and situation of these organs will comport with the physical conditions necessary for them to receive and transmit vibrations to the interior ganglia.

Naturalists, in their surmises as to the positions and forms of the organ of hearing in insects, have rarely kept in view the important consideration of those physical relations which the organ must bear to the aërial vibrations producing sound, and which we have already pointed out. The mere descriptive anatomist of former years could be satisfied with his artistic faculty for the perception of form; but the student of these days can only make progress by constantly studying the close relations which necessarily exist between the minute structure of the organs of an animal and the forces which are acting in the animal, and which traverse the medium in which the animal

lives. The want of appreciation of these relations, together with the fact that many naturalists are more desirous to describe many new forms than to ascertain the function of one well-known form which may exist in all animals of a class, has tended to keep many departments of natural history in the condition of mere descriptive science. Those who are not professed naturalists appreciate this perhaps more than the naturalists themselves, who are imbued with that enthusiasm which always comes with the earnest study of any one department of nature; for the perusal of those long and laboriously precise descriptions of forms of organs without the slightest attempt, or even suggestion, as to their uses, affects a physicist with feelings analogous to those experienced by one who peruses a well-classified catalogue descriptive of physical instruments while of the uses of these instruments he is utterly ignorant.

The following views, taken from the 'Anatomy of the Invertebrata' by C. Th. v. Siebold, will show how various are the opinions of naturalists as to the location and form of the organs of hearing in the Insecta:—"There is the same uncertainty concerning the organs of audition [as concerning the olfactory organs]. Experience having long shown that most insects perceive sounds, this sense has been located sometimes in this and sometimes in that organ. But in their opinion it often seems to have been forgotten, or unthought of, that there can be no auditory organ without a special auditory nerve which connects directly with an acoustic apparatus capable of receiving, conducting, and concentrating the sonorous undulations. (The author who has erred most widely in this respect is Mr. L. W. Clarke in Mag. Nat. Hist., September 1838, who has described at the base of the antennæ of *Carabus nemoralis*, Illig., an auditive apparatus composed of an auricula, a meatus auditorius externus and internus, a tympanum and labyrinthus, of all of which there is not the least trace. The two white convex spots at the base of the antennæ of *Blatta orientalis*, and which Treviranus has described as auditory organs, are, as Burmeister has correctly stated, only rudimentary accessory eyes. Newport and Goureau think that the antennæ serve both as tactile and as auditory organs. But this view is inadmissible, as Erichson has already stated, except in the sense that the antennæ, like all solid bodies, may conduct sonorous vibrations of the air; but even admitting this view, where is the auditory nerve? for it is not at all supposable that the antennal nerve can serve at the same time the function of two distinct senses.)

"Certain Orthoptera are the only Insecta with which there

has been discovered in these later times a single organ having the conditions essential to an auditory apparatus. This organ consists, in the Acrididæ, of two fossæ or conchs, surrounded by a projecting horny ring, and at the base of which is attached a membrane resembling a tympanum. On the internal surface of this membrane are two horny processes, to which is attached an extremely delicate vesicle filled with a transparent fluid and representing a membranous labyrinth. This vesicle is in connexion with an auditory nerve which arises from the third thoracic ganglion, forms a ganglion on the tympanum, and terminates in the immediate neighbourhood of the labyrinth by a collection of cuneiform staff-like bodies with very finely pointed extremities (primitive nerve-fibres?), which are surrounded by loosely aggregated ganglionic globules. (This organ has been taken for a soniferous apparatus by Latreille. J. Müller was the first who fortunately conceived that in *Gryllus hieroglyphus* this was an auditory organ. He gave, however, the interpretation only as hypothetical; but I have placed it beyond all doubt by careful researches made on *Gomphoceros*, *Edipoda*, *Podisma*, *Caloptenus*, and *Truxalis*.)

“The Locustidæ and Achetidæ have a similar organ situated in the fore legs directly below the femoro-tibial articulation. With a part of the Locustidæ (*Meconema*, *Barbitistes*, *Phaneroptera*, *Phylloptera*), there is on each side of this point a fossa, while with another portion of this family there are at this same place two more or less spacious cavities (auditory capsules) provided with orifices opening forward. These fossæ and these cavities have each on their internal surface a long-oval tympanum. The principal trachean trunk of the leg passes between two tympanums, and dilates at this point into a vesicle whose upper extremity is in connexion with a ganglion of the auditory nerve. This last arises from the first thoracic ganglion, and accompanies the principal nerve of the leg. From the ganglion in question passes off a band of nervous substance which stretches along the slightly excavated anterior side of the trachean vesicle. Upon this band is situated a row of transparent vesicles containing the same kind of cuneiform staff-like bodies, mentioned as occurring in the Acrididæ. The two large trachean trunks of the fore legs open by two wide infundibuliform orifices on the posterior border of the prothorax; so that here, as in the Acrididæ, a part of this trachean apparatus may be compared to a tuba Eustachii. In the Achetidæ there is on the external side of the tibia of the fore legs an orifice closed by a white silvery membrane (tympanum), behind which is an auditory organ like that just described. (With *Acheta achatina* and *italica* there is a tympanum

of the same size on the internal surface of the legs in question; but it is scarcely observable in *A. sylvestris*, *A. domestica*, and *A. campestris*.)”

Other naturalists have placed the auditory apparatus of diurnal Lepidoptera in their club-shaped antennæ, of bees at the root of their maxillæ, of *Melolontha* in their antennal plates, of *Locusta viridissima* in the membranes which unite the antenna with the head.

I think that Siebold assumes too much when he states that the existence of a tympanic membrane is the only test of the existence of an auditory apparatus. It is true that such a test would apply to the non-aquatic vertebrates; but their homologies do not extend to the articulates; and besides, any physicist can not only conceive of, but can actually construct other receptors of ærial vibrations, as I will soon show by conclusive experiments. Neither can I agree with him in supposing that the antennæ are only tactile organs; for very often their position and limited motion would exclude them from this function\*; and moreover it has never been proved that the antennæ, which differ so much in their forms in different insects, are always tactile organs. They may be used as such by some insects; in others they may be organs of audition; while in other insects they may, as Newport and Goureau surmise, have both functions; for even granting that Müller's law of the specific energy of the senses extends to the insects, yet the anatomy of their nervous system is not sufficiently known to prevent the supposition that there may be two distinct sets of nerve-fibres in the antennæ or in connexion with their bases, so that the antennæ may serve both as tactile and as auditory organs—just as the hand, which receives at the same time the impression of the character of the surface of a body and of its temperature—or like the tongue, which at the same time distinguishes the surface, the form, the temperature, and the taste of a body. Finally, I take objection to this statement:—“Newport and Goureau think that the antennæ serve both as tactile and as auditory organs. But this view is inadmissible, as Erichson has already stated, except in the sense that the antennæ, like all solid bodies, may conduct sonorous vibrations of the air.” Here evidently Siebold had not in his mind the physical relations which exist between two bodies which give exactly the same number of vibrations; for it is well known that when one of them vibrates, the other will be set into vibration by the impacts sent to it through the interve-

\* Indeed they are often highly developed in themselves while accompanied by *palpi*, which are properly placed, adequately organized, and endowed with a range of motion suitable to an organ intended for purposes of touch.

ning air. Thus, if the fibrillæ on the antennæ of an insect should be tuned to the different notes of the sound emitted by the same insect, then when these sounds fell upon the antennal fibrils the latter would enter into vibration with those notes of the sound to which they were severally tuned; and so it is evident that not only could a properly constructed antenna serve as a receptor of sound, but it would also have a function not possible in a membrane; that is, it would have the power of analyzing a composite sound by the covibration of its various fibrillæ to the elementary tones of the sound.

The fact that the existence of such an antenna is not only supposable, but even highly probable, taken in connexion with an observation I have often made in looking over entomological collections, viz. that fibrillæ on the antennæ of nocturnal insects are highly developed, while on the antennæ of diurnal insects they are either entirely absent or reduced to mere rudimentary filaments, caused me to entertain the hope that I should be able to confirm my surmises by actual experiments on the effects of sonorous vibrations on the antennal fibrillæ; also the well-known observations of Hensen\* encouraged me to seek in aerial insects for phenomena similar to those he had found in the decapod the *Mysis*, and thus to discover in nature an apparatus whose functions are the counterpart of those of the apparatus with which I gave the experimental confirmation of Fourier's theorem, and similar to the supposed functions of the rods of the organ of Corti.

The beautiful structure of the plumose antennæ of the male *Culex mosquito* is well known to all microscopists; and these organs at once recurred to me as suitable objects on which to begin my experiments. The antennæ of these insects are twelve-jointed; and from each joint radiates a whorl of fibrils; and the latter gradually decrease in their lengths as we proceed from those of the second joint from the base of the antenna to those of the second joint from the tip. These fibrils are highly elastic, and so slender that their lengths are over three hundred times their diameters. They taper slightly, so that the diameter at the base is to the diameter near the tip as 3 to 2.

I cemented a live male mosquito with shellac to a glass slide, and brought to bear on various fibrils a one-fifth objective. I then sounded successively, near the stage of the microscope, a series of tuning-forks with the openings of their resonant boxes turned towards the fibrils. On my first trials with an  $Ut_4$  fork of 512 vibrations per second, I was delighted with the results of the experiments; for I saw certain of the fibrils enter into vigorous vibration, while others remained comparatively at rest.

\* "Studien über das Gehörorgan der Decapoden," Siebold und Kölliker's *Zeitschrift für wissenschaftliche Zoologie*, vol. xiii.

The Table of experiments which I have given is characteristic of all of the many series which I have made. In the first column (A) I have given the notes of the forks in the French notation, which König stamps upon his forks. In the second (B) are the amplitudes of the vibrations of the end of the fibril in divisions of the micrometer-scale; and in column C are the values of these divisions in fractions of a millimetre.

A.	B.	C.
Ut <sub>2</sub> . .	0·5 div.	·0042 millim.
Ut <sub>3</sub> . .	2·5 „	·0200 „
Mi <sub>3</sub> . .	1·75 „	·0147 „
Sol <sub>3</sub> . .	2·0 „	·0168 „
Ut <sub>4</sub> . .	6·0 „	·0504 „
Mi <sub>4</sub> . .	1·5 „	·0126 „
Sol <sub>4</sub> . .	1·5 „	·0126 „
B <sub>4</sub> <sup>b-</sup> . .	1·5 „	·0126 „
Ut <sub>5</sub> . .	2·0 „	·0168 „

The superior effect of the vibrations of the Ut<sub>4</sub> fork on the fibril is marked; but thinking that the differences in the observed amplitudes of the vibrations might be owing to differences in the intensities of the various sounds, I repeated the experiment, but vibrated the forks which gave the greater amplitudes of covibration with the lowest intensities; and although I observed an approach toward equality of amplitude, yet the fibril gave the maximum swings when Ut<sub>4</sub> was sounded; and I was persuaded that this special fibril was tuned to unison with Ut<sub>4</sub> or to some other note within a semitone of it. The differences of amplitude given by Ut<sub>4</sub> and Sol<sub>3</sub> and Mi<sub>4</sub> are considerable; and the Table also brings out the interesting observation that the lower (Ut<sub>3</sub>) and the higher (Ut<sub>5</sub>) harmonics of Ut<sub>4</sub> cause greater amplitudes of vibration than any intermediate notes. As long as a universal method for the determination of the relative intensities of sounds of different pitch remains undiscovered, so long will the science of acoustics remain in its present vague qualitative condition\*. Now, not having the means of equalizing the intensities of the vibrations issuing

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\* I have recently made some experiments in this direction, which show the possibility of eventually being able to express the intensity of an aerial vibration directly in fraction of Joule's dynamical unit, by measuring the heat developed in a slip of sheet rubber stretched between the prongs of a fork and enclosed in a compound thermo-battery. The relative intensities of the aerial vibration produced by the fork when engaged in heating the rubber and when the rubber is removed, can be measured by the method I described in the *Philosophical Magazine*, 1873, vol. xlv. p. 18. Of course, if we can determine the amount of heat produced per second by a known fraction of

from the various resonant boxes, I adopted the plan of sounding with a bow each fork with the greatest intensity I could obtain. I think that it is to be regretted that König did not adhere to the form of fork with *inclined prongs* as formerly made by Marloye; for with such forks one can always reproduce the same initial intensity of vibration by separating the prongs by means of the same cylindrical rod, which is drawn between them. Experiments similar to those already given revealed a fibril tuned to such perfect unison with  $Ut_3$  that it vibrated through 18 divisions of the micrometer, or .15 millim., while its amplitude of vibration was only 3 divisions when  $Ut_4$  was sounded. Other fibrils responded to other notes; so that I infer from my experiments on about a dozen mosquitos that their fibrils are tuned to sounds extending through the middle and next higher octave of the piano.

To subject to a severe test the supposition I now entertained, that the fibrils were tuned to various periods of vibration, I measured with great care the lengths and diameters of two fibrils, one of which vibrated strongly to  $Ut_3$ , the other as powerfully to  $Ut_4$ ; and from these measures I constructed in homogeneous pine-wood two gigantic models of the fibrils, the one corresponding to the  $Ut_3$  fibril being about 1 metre long. After a little practice I succeeded in counting readily the number of vibrations they gave when they were clamped at one end and drawn from a horizontal position. On obtaining the ratio of these numbers, I found that it coincided with the ratio existing between the numbers of vibrations of the forks to which covibrated the fibrils of which these pine-rods were models.

The consideration of the relations which these slender, tapering, and pointed fibrils must have to the aerial pulses acting on them, led me to discoveries in the physiology of audition which I imagine are entirely new. If a sonorous wave falls upon one of these fibrils so that its wave-front is at right angles to the

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the intensity, we have the amount produced by the vibration with its entire intensity. Then means can be devised by which the aerial vibration produced by this fork can always be reproduced with the same intensity. This intensity, expressed in fraction of Joule's unit, is stamped upon the apparatus, which ever afterward serves as a true measure for obtaining the intensities of the vibrations of all simple sounds having the same pitch as itself. The same operation can be performed on other forks of different pitch; and so a series of intensities of different periods of vibration is obtained expressed in a corresponding series of fractions of Joule's unit. Recent experiments have given  $\frac{1}{1000000}$  of a Joule's unit as the approximate dynamic equivalent of ten seconds of aerial vibrations produced by an  $Ut_3$  fork set in motion by intermittent electromagnetic action and placed before a resonator.

fibril, and hence the direction of the pulses in the wave are in the direction of the fibril's length, the latter cannot be set in vibration; but if the vibrations in the wave are brought more and more to bear athwart the fibril, it will vibrate with amplitudes increasing until it reaches its maximum swing of co-vibration, when the wave-front is parallel to its length, and therefore the direction of the impulses on the wave are at right angles to the fibril. These curious surmises I have confirmed by many experiments made in the following manner. A fork which causes a strong covibration in a certain fibril is brought near the microscope, so that the axis of the resonant box is perpendicular to the fibril, and its opening is toward the microscope. The fibril in these circumstances enters into vigorous vibration on sounding the fork; but on moving the box round the stage of the microscope so that the axis of the box always points toward the fibril, the amplitudes of vibration of the fibril gradually diminish; and when the axis of the box coincides with the length of the fibril, and therefore the sonorous pulses act on the fibril in the direction of its length, the fibril is absolutely stationary, and even remains so when the fork in this position is brought quite close to the microscope. These observations at once revealed to me another function of these organs: for if, for the moment, we assume that the antennæ are really the organs which receive aërial vibrations and transmit them to an auditory capsule, or rudimentary labyrinth, then these insects must have the faculty of the perception of the direction of sound more highly developed than in any other class of animals. The following experiments will show the force of this statement, and at the same time illustrate the manner in which these insects determine the direction of a sonorous centre. I placed under the microscope a live mosquito, and kept my attention fixed upon a fibril which covibrated to the sound of a tuning-fork which an assistant placed in unknown positions around the microscope. I then rotated the stage of the instrument until the fibril ceased to vibrate, and then drew a line on a piece of paper under the microscope in the direction of the fibril. On extending this line I found that it always cut within  $5^{\circ}$  of the position of the source of the sound. The antennæ of the male mosquito have a range of motion in a horizontal direction, so that the angle included between them can vary considerably inside and outside of  $40^{\circ}$ \*; and I conceive that this is the manner in which these insects during night direct their flight toward the female. The song of the female vibrates the

\* The shafts of the antennæ include an angle of about  $40^{\circ}$ . The basal fibrils of the antennæ form an angle of about  $90^{\circ}$ , and the terminal fibrils an angle of about  $30^{\circ}$ , with the axis of the insect.



fibrillæ of one of the antennæ more forcibly than those of the other. The insect spreads the angle between his antennæ, and thus, as I have observed, brings the fibrillæ, situate within the angle formed by the antennæ, in a direction approximately parallel to the axis of the body. The mosquito now turns his body in the direction of that antenna whose fibrils are most affected, and thus gives greater intensity to the vibrations of the fibrils of the other antenna. When he has thus brought the vibrations of the antennæ to equality of intensity, he has placed his body in the direction of the radiation of the sound, and he directs his flight accordingly; and from my experiments it would appear that he can thus guide himself to within 5° of the direction of the female.

Some may assume (as I did when I began this research), from the fact of the covibration of these fibrils to sounds of different pitch, that the mosquito has the power of decomposing the sensation of a composite sound into its simple components, as is done by the higher vertebrates; but I do not hold this view, but believe that the range of covibration of the fibrils of the mosquito is to enable it to apprehend the ranging pitch of the sounds of the female. In other words, the want of definite and fixed pitch to the female's song demands for the receiving-apparatus of her sounds a corresponding range of covibration; so that, instead of indicating a high order of auditory development, it is really the lowest, except in its power of determining the direction of a sonorous centre, in which respect it surpasses by far our own ear\*.

The auditory apparatus we have just described does not in the least confirm Helmholtz's hypothesis of the functions of the organ of Corti; for the supposed power of that organ to decompose a sonorous sensation depends upon the existence of an audi-

\* Some physiologists, attempting to explain the function of the semicircular canals, assume, because these canals are in three planes at right angles to each other, that they serve to fix in space a sonorous centre, just as the geometrician by his three coordinate planes determines the position of a point in space. But this assumption is fanciful and entirely devoid of reason; for the semicircular canals are always in the same dynamic relation to the tympanic membrane which receives the vibration, to be transmitted always in one way through the ossicles to the inner ear. Really we determine the direction of a sound by the difference in the intensities of the effects produced in the two ears; and this determination is aided by the form of the outer ear, and by the fact that man can turn his head around a vertical axis. Other mammalia, however, having the axis of rotation of the head more or less horizontal, have the power of facilitating the determination of motion by moving the axis of their outer ears into different directions. It is also a fact that, when one ear is slightly deaf, the person unconsciously so affected always supposes a sound to come from the side on which is his good ear.

tory nerve differentiated as highly as the covibrating apparatus, and in the case of the mosquito there is no known anatomical basis for such an opinion. In other words, my researches show external covibrating organs whose functions replace those of the tympanic membrane and chain of ossicles in receiving and transmitting vibrations; while Helmholtz's discoveries point to the existence of internal covibrating organs which have no analogy to those of the mosquito, because the functions of the former are not to receive and transmit vibrations to the sensory apparatus of the ear, but to give the sensation of pitch and to decompose a composite sonorous sensation into its elements; and this they can only do by their connexion with a nervous development whose parts are as numerous as those of the covibrating mechanism. Now, as such a nervous organization does not exist in insects, it follows that neither anatomical nor functional relations exist between the covibrating fibrils on the antennæ and the covibrating rods in the organ of Corti, and therefore that neither Hensen's observations on the *Mysis* (assumed by Helmholtz to confirm his hypothesis) nor mine on the mosquito can be adduced in support of Helmholtz's hypothesis of audition\*.

The above-described experiments were made with care; and I think that I am authorized to hold the opinion that I have established a physical connexion existing between the sounds emitted by the female and the covibrations of the antennal fibrillæ of the male mosquito; but only a well-established physiological relation between these covibrating parts of the animal and the development of its nervous system will authorize us to state that these are really the auditory organs of the insect. At this stage of the investigation I began a search through the zoological journals, and found nearly all that I could desire in a paper in vol. iii. (1855) of the 'Quarterly Journal of the Microscopical Society,' entitled "Auditory Apparatus of the *Culex mosquito*," by Christopher Johnston, M.D., Baltimore, U. S.

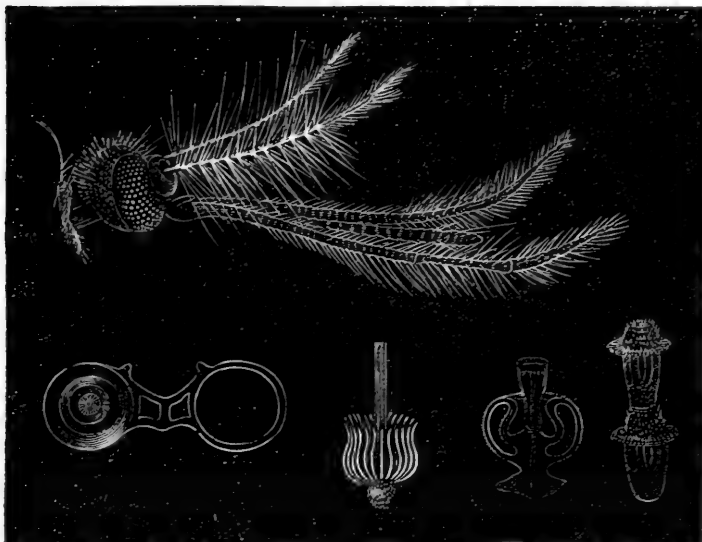
In this excellent paper I found clear statements showing that its talented author had surmised the existence of some of the physical facts which my experiments and observations have established †. To show that anatomical facts conform to the

\* Also, the organ of Corti having disappeared in the lower vertebrates, it is not likely that it would reappear in the Articulata; and especially will this opinion have weight when we consider that the peculiar function of the organ of Corti is the appreciation of those composite sounds whose signification mammals are constantly called upon to interpret.

† A short time before the death of my friend Professor Agassiz, he wrote me these words:—"I can hardly express my delight at reading your letter. I feel you have hit upon one of the most fertile mines for the elucidation of a problem which to this day is a puzzle to naturalists, the seat of the organ of hearing in Articulates."

hypothesis that the antennal fibrils are the auditory organs of the mosquito, I cannot do better than quote the following from Dr. Johnston's paper:—

“While bearing in mind the difference between *feeling a noise* and *perceiving a vibration*, we may safely assume with Carus—for a great number of insects at least—that whenever true auditory organs are developed in them, their seat is to be found in the neighbourhood of the *antennæ*. That these parts themselves are in some instances concerned in collecting and transmitting sonorous vibrations, we hold as established by the observations we have made, particularly upon the *Culex mosquito*; while we believe, as Newport has asserted in general terms, that they serve also as tactile organs.



“The male mosquito differs considerably, as is well known, from the female, his body being smaller and of a darker colour, and his head furnished with *antennæ* and *palpi* in a state of greater development (see figure). Notwithstanding the fitness of his organs for predatory purposes, he is timid, seldom entering dwellings or annoying man, but restricts himself to damp and foul places, especially sinks and privies. The female, on the other hand, gives greater extension to her flight, and, attacking our race, is the occasion of no inconsiderable disturbance and vexation during the summer and autumn months.

“The head of the male mosquito, about 0·67 millim. wide, is

provided with lunate eyes, between which in front superiorly are found two pyriform capsules nearly touching each other, and having implanted into them the very remarkable antennæ.

"The capsule, measuring about 0·21 millim., is composed of a horny substance, and is attached posteriorly by its pedicle, while anteriorly it rests upon a horny ring united with its fellow by a transverse fenestrated band, and to which it is joined by a thin elastic membrane. Externally it has a rounded form, but internally it resembles a certain sort of lamp-shade with a constriction near its middle; and between this inner cup and outer globe there exists a space, except at the bottom or proximal end, where both are united.

"The antennæ are of nearly equal length in the male and the female.

"In the male the antenna is about 1·75 millim. in length, and consists of fourteen joints, twelve short and nearly equal, and two long and equal terminal ones, the latter measuring (together) 0·70 millim. Each of the shorter joints has a fenestrated skeleton with an external investment, and terminates simply posteriorly, but is encircled anteriorly with about forty *papillæ*, upon which are implanted long and stiff hairs, the proximal sets being about 0·79 millim. and the distal ones 0·70 millim. in length; and it is beset with minute bristles in front of each whorl.

"The two last joints have each a whorl of about twenty short hairs near the base.

"In the female the joints are nearly equal, number but thirteen, and have each a whorl of about a dozen small hairs around the base. Here, as well as in the male, the parts of the antennæ enjoy a limited motion upon each other, except the basal joint, which, being fixed, moves with the capsule upon which it is implanted.

"The space between the inner and outer walls of the capsule, which we term confidently the auditory capsule\*, is filled with a fluid of moderate consistency, opalescent, containing minute spherical corpuscles, and which probably bears the same relation to the nerve as does the lymph in the scalæ of the cochlea of higher animals. The nerve itself of the antenna proceeds from the first or cerebral ganglion, advances toward the pedicle of the capsule in company with the large trachea, which sends its ramifications throughout the entire apparatus; and penetrating the pedicle, its filaments divide into two portions. The central threads continue forward into the antenna, and are lost there; the peripheral ones, on the contrary, radiate

\* See figure, page 361.

outward in every direction, enter the capsular space, and are lodged there for more than half their length in *sulci* wrought in the inner wall or cup of the capsule.

“In the female the disposition of parts is observed to be nearly the same, excepting that the capsule is smaller, and that the last distal antennal joint is rudimental.

“The proboscis does not differ materially in the two sexes; but the palpi, although consisting in both instances of the same number of pieces, are very unlike. In the female they are extremely short, but in the male attain the length of 2·73 millims., while the proboscis measures but 2·16 millims. They are curved upward at the extremity.

“... The position of the capsules strikes us as extremely favourable for the performance of the function which we assign to them; besides which there present themselves in the same light the anatomical arrangement of the capsules, the disposition and lodgment of the nerves, the fitness of the expanded whorls for receiving, and of the jointed antennæ fixed by the immovable basal joint for transmitting vibrations created by sonorous undulations. The intracapsular fluid is impressed by the shock, the expanded nerve appreciates the effect of the sound by the quantity of the impression, of the pitch or quality by the consonance of particular whorls of stiff hairs according to their lengths, and of the direction in which the undulations travel by the manner in which they strike upon the antennæ or may be made to meet either antenna in consequence of an opposite movement of that part.

“That the male should be endowed with superior acuteness of the sense of hearing appears from the fact that he must seek the female for sexual union either in the dim twilight or in the dark night, when nothing but her sharp humming noise can serve him as a guide. The necessity for an equal perfection of hearing does not exist in the female; and accordingly we find that the organs of the one attain a development which the other's never reach. In these views we believe ourselves to be borne out by direct experiment, in connexion with which we may allude to the greater difficulty of catching the male mosquito.

“In the course of our observations we have arrived at the conclusion that the antennæ serve to a considerable extent as organs of touch in the female; for the palpi are extremely short, while the antennæ are very movable and nearly equal the proboscis in length. In the male, however, the length and perfect development of the palpi would lead us to look for the seat of the tactile sense elsewhere; and in fact we find the two apical antennal joints to be long, movable, and compara-

tively free from hairs, and the relative motion of the remaining joints very much more limited.”

My experiments on the mosquito began late in the fall; and therefore I was not able to extend them to other insects. This spring I purpose to resume the research, and will experiment especially on those Orthoptera and Hemiptera which voluntarily emit distinct and characteristic sounds.

PROCEEDINGS OF LEARNED SOCIETIES.

ROYAL SOCIETY.

December 17, 1874.—Joseph Dalton Hooker, C.B., President, in the Chair.

Letters received from the Naturalists attached to the Transit-of-Venus Expedition at Rodriguez.

Government House, Port Mathurin,  
Rodriguez, Nov. 2, 1874.

DEAR SIR,—I write to give you a short account of my proceedings and success here so far, in my explorations of the Rodriguez bone-caverns.

I must confess to a more or less degree of disappointment on my first inspection of the caverns; and you will understand the cause, I think, when I inform you that out of thirteen caves which I found on my arrival, and which I believed till lately to be the only ones, twelve bore evident, and some recent, signs of previous digging. However, I set to work at once, and, with much diligent search, had found five new caves by the time that we had finished the first thirteen. Out of these I have reason to believe that, in three of them, no mortal foot has ever been previous to mine; for the mouths of all were closed up by a falling-in of the rock; and it was by this sign that I guessed at their existence. We had to work some time at all of them with a big iron mallet before entrance could be effected. In one of these caves I believe I found the bones of two Solitaires, without admixture of those of any other individuals. Of the truth of this I am pretty certain; for they were clearly the bones of a male and female which had fallen down into a cleft, from which egress to so unwieldy a bird was impossible.

Some of the bones had fallen into dust from exposure to the air, being only partially covered with sand, whilst others had been altogether removed: whether by water or not I could not say; for I found no trace of its action there. The same cause, decay, which had nearly annihilated others might have entirely removed these. I found amongst these about thirty rings of the trachea or tracheæ.

Since then I have found a small nook in another cave, to which it was difficult, from the small size of the entrance, to penetrate. Into this also a slit or cleft from the surface had led, but had since been obliterated. In this I found, I should say, seven "sets" of bones of Solitaire. These were more or less mixed up together by the action of water; but they were still, to a certain extent, in groups, each group being those of an individual. Amongst these I found a perfect skull, with maxillæ attached, and the three parts of the mandible lying close by, four perfect and several injured furculæ, and many rings of tracheæ.

I propose soon to try my fortune in a small marsh near here, which looks as if it might originally have been a lakelet or pond. I am induced to do so by the success that my labours met with in a similar locality in Mauritius. I have said "near here;" but this is a slip of the pen; I should have said "near my encampment at the caverns."

I have found an immense quantity of tortoise-bones, from which I shall only make a selection before leaving. I have also exhumed a great quantity of bones of smaller birds; but I rather hesitate before giving a description of their genera.

I am afraid that I cannot send any bones by this mail, as the difficulty of transport is so very great. I have every week brought back a few bones of Solitaire, but have had hardly any time to put even these in gelatine, without which operation they would not travel with any degree of safety.

I am, dear Sir,

Very obediently yours,

HENRY H. SLATER.

To Prof. Huxley.

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Rodriguez, Nov. 3, 1874.

MY DEAR SIR,—A mail being about to leave the island by H.M.S. 'Shearwater,' I now send you some account of my proceedings up to the present time.

I have searched for frogs, more especially tree-frogs; but all the natives of the island tell me that there are none; and as I have neither heard nor seen them, I conclude that this must be the case. With regard to lizards, there is a small house-lizard very abundant. It belongs to the genus *Peripia*, and is very probably the same as that found in Mauritius. It is not only found in houses, but also in trees, beneath the bark of which it lays its eggs. I have been told of a much larger lizard which inhabits a certain part of the island, and have myself searched the spot, but have been unable to find it. I have also offered a reward for a specimen, but have not yet procured one.

The same has been the case with regard to another lizard, which lives on Frigate Island, a small island lying off the coast of Rodriguez.

With regard to freshwater fish, there are said to be four kinds, viz. :—

1. A species of perch, commonly called carp here.

2. A species of eel, in most points agreeing with *Anquilla marmorata*, but differing in one important point at least. It undoubtedly enters the streams here, as the specimen which I have was caught about a quarter of a mile above the place whence we get our drinking-water.

3. A species of *Eleotris*, a specimen of which was caught at the same place as the eel. This fish, however, undoubtedly enters brackish water.

4. A species of *Mugil*. I have my doubts as to whether this fish can really be called a freshwater species.

With regard to the Arachnida, I have collected a considerable quantity of spiders, and have got specimens of the small scorpion which is very fairly common on the island.

A large *Scolopendra* is very common; but a small species is not so, and I have only succeeded in procuring one specimen.

I have collected a very considerable quantity of insects, more especially of the order Coleoptera.

*Peripatus* I have not been able to find, though I have made diligent search for it.

There are two species of land-crab, both of which I have procured.

I have only been able to find one very minute species of freshwater sponge, which seems to be very rare. I have only found two small specimens, which, however, came from two streams in widely different parts of the island.

The Vermes are not numerously represented on the island. There are one or two species of *Lumbricus*. There are no leeches in the streams, nor are there planarians either there or on land. There is, however, a beautiful nemertine, which I have found under stones and wood in damp places. I have also found a species of *Gordius* in a stream.

Believe me,

Yours truly,

GEORGE GULLIVER.

The Secretary R.S.

P.S.—I do not send any specimens home at present, as, being nearly all in spirit, they still want attention, and it is also necessary for me to keep specimens by me, in order to ascertain whether I have already got specimens which I may find.

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Rodriguez, November 1874.

SIR,—I send by the 'Shearwater' to-morrow, for transmission by the mail leaving Mauritius on the 12th instant, a packet of seeds of some of the plants of this island; and, in accordance with my instructions, I submit the following short report of my proceedings here up to the present date.



I have paid special attention to the Palms and *Pandani*. Of the former there are three species indigenous—one of the genus *Latania*, and two belonging to the genus *Areca*. The *Pandani* present much greater difficulty in their determination; and I do not yet feel in a position to fix definitely the number of species, although I rather incline to the idea that there are only two true species. My collection of the plants of the island now numbers about 450 species, of which about three fourths are Phænogams. I have made observations with the view of discriminating between the indigenous and introduced vegetation, but there are several plants regarding which I am doubtful. I have not yet succeeded in finding any marine Phænogams; hitherto, however, I have not devoted much time to the marine flora. There are no tree ferns on the island; at least I have seen none, and, as far as I can learn, none of the inhabitants have seen any. Ferns are represented by about two dozen species; mosses and freshwater algæ are not abundant, but lichens are very numerous, both as species and as individuals. This flora is by no means so extensive as I had expected; but the survey of the island just concluded by the officers of the 'Shearwater' shows the island is only about half the size it was previously supposed to be, it being only 11 miles long by 4 miles broad. The island is a volcanic one, consisting of a succession of lava-flows, radiating from one or more foci in the centre of the island, and now worn away so as to form a series of more or less parallel ridges, separated by deep ravines. These lava-flows are composed chiefly of a dark compact basalt, not unfrequently becoming porphyritic, and commonly exhibiting a marked columnar structure; and I have counted as many as twelve such flows, lying one above the other, separated severally, either by beds of conglomerate, or by beds of laterite, or variously coloured clayey beds. Granite and sandstone do not occur in the island. At the east and at the west ends of the island occur the only non-volcanic rock in the island, namely coralline limestone, extending in huge sheets over many acres of land, and also occurring in detached patches on the top of the basalt, often nearly a mile from the sea. On the northern and southern sides of the island it does not occur; but on the southern side may be seen some raised beaches, marking upheaval there, as does the coralline limestone at the east and west sides. Zeolites are common in the basalt in many places, as also several other minerals. The whole rocks of the island are permeated by iron. This report is very brief; but I have abstained from entering into details regarding the botany and geology of the island, leaving that for the full report to be given in on my return. I trust, however, the above is sufficient to show that I have made some progress towards accomplishing the objects for which I was sent out here.

I am, Sir,

Yours faithfully,

IS. BAYLEY BALFOUR.

To the Secretary of  
the Royal Society.

## MISCELLANEOUS.

*Ceratodus Forsteri* and *C. miolepis*. By Dr. A. B. MEYER.

DR. GÜNTHER separates, in his valuable memoir on *Ceratodus* (Phil. Trans. 1871, part ii. p. 516), *Ceratodus Forsteri*, Krefft, and *C. miolepis*, Gthr., as two species, chiefly because the former has 18 series of scales, 5 above and 11 below the lateral lines, the latter 21, 6 above and 13 below. The Royal Natural-History Museum of Dresden possesses a specimen of *Ceratodus* from Gayndah, Burnett River, Wide-Bay district, Queensland (procured through the Museum Godeffroy of Hamburg), which has 19 series of scales, 5 above and 12 below the lateral lines. It stands in this respect between the supposed two species *Ceratodus Forsteri*, Krefft, and *C. miolepis*, Gthr.; and I therefore presume that this character is in such a way variable that a specific difference cannot be founded on it, and that *C. miolepis*, Gthr., must be united with *C. Forsteri*, Krefft. The specimen in the Dresden Museum is about 93 centims. in length.

*On an Apparatus of Dissemination of the Gregarinæ and the Stylo-rhynchi; and on a Remarkable Phase of Sporulation in the latter Genus.* By M. A. SCHNEIDER.

In the course of a revision of the group of the *Gregarinæ*, which I undertook by the advice and under the auspices of M. de Lacaze-Duthiers, besides numerous facts of detail rectifying or completing the ideas already acquired, I have met with some entirely new peculiarities, of which I will give a brief *résumé*.

These observations are taken from the first part of a memoir on the group of the *Gregarinæ*, in which I give the history and description of the species which inhabit the Invertebrata of the environs of Paris and the marine Invertebrata of the beach of Roseoff.

It is well known that the Gregarinida, on attaining the termination of their individual growth, encyst themselves, and that at the expense of their contents there are formed a considerable number of reproductive bodies, designated under the names of "pseudonavicellæ" and "psorospermeæ," which I propose to call simply "spores," by an application of general nomenclature, wishing to express by this term that the bodies in question do not require the concurrence of a male element in order to commence their evolution.

From the existing data, the mature cyst opens by the rupture of the integument and liberates the spores. A very remarkable exception to the general law is presented by the two genera *Gregarina* and *Stylorhynchus*. But the mode of formation of this apparatus had escaped me; and its ascertainment was nevertheless exceedingly important, both for the legitimation of the discovery and for the sound interpretation of the organic arrangements which had been proved. I have since been able to trace carefully the formation of this apparatus of dissemination; and the following is the way in which it is accomplished:—The cyst early shows, in its clear marginal zone, the appearance of a variable number of tubes, each directed in accordance with a radius of the cyst. At first without

connexion with the wall, they at last attach themselves to it by virtue of centrifugal development, and finally unite with it by their peripheral extremity, while by the opposite extremity they converge towards the centre of the cyst. They are formed by a structureless membrane, and originate in the midst, and doubtless also at the expense of an accumulation of granules which surround them for some time even after their complete formation, representing a sort of muff round each of them.

Each of these tubes, which I have called *sporoducts*, presents, in a state of complete individualization, a short, broad basal joint, by which it is inserted upon the internal surface of the wall of the cyst, and a slender terminal longer or shorter joint, of which the extremity corresponds to the centre of the cyst.

At maturity the sporoducts may be seen to disengage themselves with extreme rapidity, and to erect themselves outwards to their full length. In case any obstacle obstructs the phenomena of their erection, we may easily trace its mechanism. We may then see the sporoduct free itself gradually by a true evagination, the basal joint appearing first of all, and the extremity of the tube last, after having traversed all the portion already emitted. This mechanism can only be the effect of an augmentation of pressure of the contents of the cyst, doubtless correlative to a change of its mean density under the influence of the remarkable modifications that these contents undergo in the course of sporulation; and the same cause would also direct the expulsion of the spores through the sporoducts.

The genus *Stylorhynchus* (*S. oblongatus*, Hamm., from *Opatrum sabulosum*) presents perhaps yet more interesting phenomena. The cyst, which is produced by solitary encystment, presents at first uniform contents, which are afterwards divided into two equal masses by an equatorial plane. At the same time that the traces of this first division are effaced and the granular portion of the contents becomes condensed, a great number of very shallow secondary furrows appear, which subdivide the outer coat of the granular contents into lobes and lobules. From the surface of these lobes and lobules one now sees the nascent spores bud. At first they are completely homogeneous and transparent, but afterwards acquire some granules before their complete individualization and separation from the lobules.

When free from all adherence to these, the sporigenous masses are situated on the surface of a voluminous central mass formed by the remains of the not utilized portion of the original contents. Then, quitting the regularly spherical form, each sporigenous mass elongates in the direction of a radius of the cyst, and all together, in the form of little fusiform bacilli, tapering at the ends and relatively very much swollen in the middle, execute, during from fifteen to eighteen hours, an interrupted series of rapid and energetic movements, by which their peripheral extremity inflects itself first in one direction and then in another, at the same time that the corpuscle shortens and lengthens itself, and the granules which it encloses are agitated in its interior in all directions. The movement of each corpuscle is independent of that of its neighbour; and those which

are completely isolated in the liquid interposed between the solid contents of the cyst and its wall move like the others.

After the lapse of time indicated, this movement of all the sporigenous masses ceases suddenly; each corpuscle returns to a spherical, or nearly spherical, form, and becomes converted into a definitive spore by the production of a thick wall on its surface. In its turn, the voluminous central mass of granules on which the spores rest becomes surrounded also with a proper coat, and converted into a vesicle enclosed in the cyst and free at all parts. This *pseudocyst*, as I call it, is in my eyes an agent in a new mode of spore-dissemination. By its subsequent growth it presses on the spores compressed between the opposite surfaces of the two spheres, causes the rupture of the exterior tegument, and consequently the liberation of the reproductive bodies.

Out of thirty genera that I have examined, the existence of an apparatus of dissemination is only met with in the two genera just cited. Genera very nearly allied to *Gregarina* or *Stylorhynchus* do not offer any trace of the peculiarities which characterize these latter; as, on the other hand, the sporoducts and the pseudocyst cannot be brought to a common organic expression, it is difficult to decide what value it is necessary to attribute, in the characterization of the *Gregarina*-type, to this new element. But it appears certain that this new element does not create any homology between the Gregarinidæ and the lower plants. The chemical characters of the walls of the sporoducts and of the pseudocyst, as well as the mode of their formation, do not confirm in the least the external analogy that the sporoducts of the *Gregarina* especially seem to bear at first sight to the emissory tubes of the spores of some Chytridieæ.—*Comptes Rendus*, February 15, 1875, p. 432.

#### *Researches into the History of the Rhizopods.*

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

GENTLEMEN,—It has been brought to my notice, but only within the present month, that towards the close of last year Professor Leidy published, in some of the American scientific journals, an account of researches he had made into the history of the freshwater Rhizopods, more especially the *Amœbæ* and *Diffugiæ*.

I am delighted to find that observations, nearly all of which (even to the supposed discovery by Professor Leidy of the very remarkable form for which he has suggested the name *Ouramœba*) were embodied by me in a series of papers, accompanied by illustrative figures, which appeared in the 'Annals and Magazine of Natural History' in April, May, June, August, November, December 1863, and March 1864, should have been so fully confirmed by such a distinguished writer. It is to be regretted, however, that Professor Leidy should have failed to make any reference whatever to my papers, although I feel satisfied the failure has been a purely unintentional one on his part.

I remain, Gentlemen,

Your most obedient Servant,  
G. C. WALLICH, M.D.

*On the Habitat of Peristethidion prionocephalum, Dum.*

By Dr. A. B. MEYER.

M. A. Duméril described and figured in the year 1868 ('Nouv. Archives du Musée d'Hist. Nat. de Paris,' vol. iv. p. 115, pl. xxiii. figs. 1 & 2) a new species of *Peristethidion*, with the remark that it was "reçu de la mer des Indes, sans indication précise d'origine." Mr. Riedel, of Gorontalo, in Celebes, asks me to make known, in his name, that the specimen was sent to Paris by him, and that the exact habitat is Gorontalo, North Celebes.

*Anatomy of a Remarkable Type of the Group of Nemertians*  
(*Drepanophorus spectabilis*). By M. A. F. MARION.

In his memoir on the Nemertians, M. de Quatrefages has indicated under the name of *Cerebratulus spectabilis* a curious species, to which he ascribes a proboscis furnished with a denticulated plate. The position and relations of this strange armature are unfortunately not exactly indicated by the French naturalist; and hence M. Intosh has recently expressed doubts as to the truth of the assertion, although Grube, in mentioning the occurrence of *Cerebratulus spectabilis* in the Adriatic, says, "Proboscide falcicula denticulata instructa." It is true that the Silesian zoologist has only given a few words to this Nemertian.

I have collected in the Gulf of Marseilles some worms of this species, and I can assert the correctness of M. de Quatrefage's description. I have moreover ascertained that Keferstein examined the same animal at Saint-Waast-la-Hogue. The *Borlasia splendida* of the "Untersuchungen über niedere Seethiere" is only a *Cerebratulus spectabilis* of which the armature of the proboscis was not recognized. Lastly, I must cite a recent memoir by M. Hubrecht, which I was unable to consult until my own researches were finished. M. Hubrecht observed some specimens of *Cerebratulus spectabilis* at Naples, and established for them the genus *Drepanophorus*. The anatomical part of this memoir is unfortunately incomplete; and I therefore hasten to publish the results that I have obtained.

The largest individual that I have examined was 68 millims. in length. I was able to understand the arrangement of the integuments by operating upon living individuals. I believe that there exists beneath the hypoderma a structureless basilar layer. The annular muscular fibres are very delicate, and differ completely from the longitudinal bundles; the latter, in transverse section, have the pennate appearance indicated by Schneider and Claparède in the musculature of the earthworms and of some Chætopod Annelides.

The vascular apparatus of this Nemertian presents the surprising peculiarity of containing elliptical globules, slightly flattened, and of a red colour identical with that of the blood-globules of man. Their longest diameter is 0.01 millim. In their centre a darker portion is seen, although it is not possible to distinguish the elements

of a true cell. If we press down a part of the body, these corpuscles accumulate in certain regions of the circulatory system, and form masses of an intense red colour. The oscillations of the globules also may be followed by observing a young animal by transmitted light. The corpuscles are set in motion by a colourless liquid, in which they float without any constant direction. There is a median dorsal vessel; and two lateral vessels are situated on the ventral face. Beneath the nervous ganglia the dorsal vessel bifurcates and anastomoses with the two lateral trunks, which rise up, follow the posterior margin of the superior ganglia, and continue on to form the cephalic loop. The dorsal canal gives origin to regularly spaced transverse loops. Each of these branches is continued to the flank of the animal, then bends towards the ventral face and opens into the lateral vessel. There consequently exist numerous capillary ramifications, which are exceptional in Nemertians, but recall to mind the arrangement indicated by M. Blanchard in *Cerebratulus liguricus*.

The proboscis is greatly developed; and the animal usually projects it at the least contact. The papillæ of the extraversile region are covered with small, ovoid, pedunculate bodies. The bulb seems to be relatively narrow; its armature can be recognized only with great difficulty. It consists of a recurved, granular, yellowish plate, representing the handle of the style of the ordinary armed Nemertians, and borne upon a hyaline mass representing the "muscular setting" of the Ommatopleans. Several little points are inserted upon the keel of this plate, which is furnished with two bundles of special muscles. These points are in all respects identical with those of the style of the *Enopla*. I have counted from nine to twenty upon a single plate; the number varies with the age of the individuals. Lastly, on each side of the bulb there are eight or ten styliigerous vesicles, containing four or five points furnished with a basal ring, and similar to those which arm the central plate. It is interesting to remark that this multiplicity of the styliigerous vesicles is in agreement with the great number of small ducts belonging to the principal armature.

One cannot hesitate to admit that the structure of this proboscis necessitates the establishment of a distinct genus in the group of armed Nemertians. I adopt the name of *Drepanophorus* proposed by M. Hubrecht. This Nemertian certainly cannot remain among the unarmed *Cerebratuli*; but I cannot accept the different species adopted by the Dutch naturalist. Among the worms found at Marseilles, notwithstanding certain differences of coloration dependent on age, I only see one well-characterized form for which it is desirable to retain the specific name given by M. de Quatrefages. The geographical range of *Drepanophorus*, however, seems to be pretty large: it is not uncommon in Sicily and in the Bay of Naples; Grube has collected it in the Adriatic; it inhabits the deep coralligenous regions of the Gulf of Marseilles; and its existence in the ocean is placed beyond doubt by Kefenstein's figures.—*Comptes Rendus*, April 5, 1875, p. 893.

*Dimorphic Development and Alternation of Generations  
in the Cladocera.*

Dr. G. O. Sars has discovered a remarkable dimorphism and alternation of generations in *Leptodora hyalina* ("Om en dimorph Udvikling samt Generationsvexel hos *Leptodora*," Forhandlinger Vidensk.-Selsk. Christiania for 1873, p. 15, and plate). The development from the ordinary summer-eggs, as already described by E. P. Müller, is without metamorphosis and like that of ordinary Cladocera, the young when excluded from the egg agreeing essentially with the adult; while, according to Sars's observations, the young are excluded from the winter-eggs in a very imperfect condition, quite unlike the known young of any other Cladocera, and pass through a marked postembryonal metamorphosis. In the earliest observed stage of the young of this form, the body is obovate, wholly without segmentation, the compound eye wanting, while there is a simple eye between the bases of the antennulæ, the swimming-arms (antennæ) well developed, and the six pairs of legs represented only by minute processes projecting scarcely beyond the sides of the body. But the most remarkable feature is the presence of a pair of appendages tipped with cilia and nearly as long as the body, which are evidently homologous with the mandibular palpi of other Crustaceans, although these appendages have always been supposed to be wanting in the species of Cladocera. Two subsequent stages, gradually approaching the adult form, are described. The adults from the winter-eggs have no vestige of the mandibular palpi left; yet the simple eye (which is wholly absent in ordinary individuals developed from summer-eggs) is persistent, and thus marks a distinct generation. Three stages of the young from winter-eggs are beautifully figured upon the plate accompanying the memoir.

This remarkable species has, still more recently, been made the subject of a very elaborate memoir by Prof. Weismann of Freiburg ("Ueber Bau und Lebenserscheinungen von *Leptodora hyalina*," Zeitschrift für wissensch. Zool. xxiv., Sept. 1874, pp. 349-418, plates 33-38), who, however, had not observed the peculiar development of the winter-eggs. The occurrence of this genus in Lake Superior is noticed in this Journal, vol. vii. p. 161, 1874.—*Silliman's American Journal*, March 1875.

*On the Actiniæ of the Oceanic Coasts of France.*

By M. P. FISCHER.

The Actiniæ of the oceanic coasts of France (comprising in that geographical region the Anglo-Norman isles) number thirty-one species:—*Cerianthus membranaceus*, Gmelin; *Edwardsia Harassii*, Quatrefages; *E. tumida*, Quatref.; *E. Beautempsii*, Quatref.; *E. callimorpha*, Gosse; *Halcampa chrysanthellum*, Peach; *Peachia undata*, Gosse; *P. triphylla*, Gosse; *Anemonia sulcata*, Pennant; *Aiptasia Couchi*, Coeks; *Actinia equina*, Linné; *Metridium dianthus*, Ellis; *Cereus pedunculatus*, Pennant; *Sagartia nivea*, Gosse; *S. viduata*, Müller (including *S. troglodytes*, Johnston); *S. venusta*,

Gosse; *S. miniata*, Gosse; *S. sphyrodeta*, Gosse; *S. pellucida*, Hollard; *S. ignea*, Fischer; *S. erythrochila*, Fischer; *S. effeta*, Linné; *Adamsia palliata*, Bohadsch; *Chitonactis coronata*, Gosse; *Bunodes verrucosus*, Pennant; *B. Bulli*, Cocks; *B. biscayensis*, Fischer; *Tealia felina*, Linné; *Corynactis viridis*, Allman; *Palythoa Couchi*, Johnston; and *P. sulcata*, Gosse. Of these thirty-one species, twenty-five (that is to say, about five sixths) inhabit the seas of Great Britain, and have been described in the 'Actinologia Britannica' of Mr. Gosse. The six species which are wanting in England are *Cerianthus membranaceus*, *Edwardisia Harassii*, *E. tumida*, *Sagartia ignea*, *S. erythrochila*, and *Bunodes biscayensis*. The *Cerianthus* belongs to the Mediterranean fauna, as, perhaps, does also *Sagartia erythrochila*.

The twenty-five species of our coasts which inhabit the English seas only furnish three species which extend as far as the Mediterranean; these are *Anemonia sulcata*, *Actinia equina*, and *Adamsia palliata*.

Our French actinological fauna nevertheless differs from that of the coasts of Great Britain by the absence of several genera which have an eminently boreal character, and which are found chiefly in the Shetlands and north of Scotland; such are the genera *Phellia*, *Gregoria*, *Bolocera*, *Hormathia*, *Stomphia*, *Plyanthus*, *Capnea*, *Aureliania*, and *Zoanthus*. One can hardly cite three species of Actiniæ in the Mediterranean which are wanting on our oceanic coasts. We may conclude from this that, if our ocean shores possess many Actiniæ and few Gorgoniæ and Corals\*, the Mediterranean presents the opposite condition.

The bathymetric distribution of the Actiniæ is very simple; they nearly all live in shallow water; they are only found in the littoral zones, and that of the Laminariæ (0-28 metres) and Nullipores (28-72 metres). Beyond this point occur the greater part of the Corals which characterize the following zone, that of Brachiopods and Corals (72-184 metres).

In the littoral zone *Actinia equina*, *Anemonia sulcata*, *Sagartia ignea*, *S. erythrochila*, *Bunodes verrucosus*, *Palythoa sulcata*, &c. chiefly live.

The Laminarian zone is principally inhabited by the non-adherent Actiniæ, as well as by *Metridium dianthus*, *Sagartia sphyrodeta*, *S. pellucida*, &c.

In the zone of Nullipores, or of the great *Buccina*, we dredge up on shells *Sagartia effeta*, *S. viduata*, *Adamsia palliata*, *Chitonactis coronata*, and *Palythoa Couchi*.

All zoologists who have attended to the specific distinction of the Actiniæ have sought to establish the number of cycles and the number of tentacles in each cycle. The number of cycles is not absolute; it is not uncommon to find one cycle more or less in adult specimens of the same species: thus *Tealia felina* has five

\* The Corals of our oceanic shores are *Caryophyllia Smithi*, *Dendrophyllia cornigera*, *Desmophyllum crista-galli*, and *Paracyathus striatus*. The Gorgoniæ are *Gorgonia verrucosa*, *Pterogorgia rhizomorpha*, and *Muricea placomus*.



cycles (10, 10, 20, 40, 80) on the coasts of Normandy, and only four cycles (10, 10, 20, 40) on the English coasts\* ; but I attach little importance to this fact.

As to the number of tentacles in each cycle, it deserves careful examination ; if anomalies exist, if certain individuals escape from all rule, it is none the less evident that one may point out archetypes for the greater number of species.

1. The type with 6 tentacles and its multiples (12, 24, 48, &c.) is the commonest ; it is this that has induced some observers to suppose that all the Actiniæ were derived from it. From the observations of Mr. Gosse, and from my own, this type exists in about twenty Actiniæ of the European seas. The *Bumodes*, among others, may be considered as perfect Hexactiniæ.

2. The type with 8, and multiples of 8, tentacles is very frequent. It is indicated for nine species, to which, probably, the *Cerianthi* may be added.

3. The type with 10 tentacles is only seen in *Tealia felina* †.

4. *Palythoa sulcata* alone has 11 tentacles.

5. These various types combine among themselves ; thus the formula of *Edwardsia carnea* would be 8, 8, 12, and that of *Corynactis viridis* 16, 24, 32, 32.

6. Lastly, there exist indeterminate types ; must we refer to type 6, 12, &c., or to a type 9, 18, and its multiples, the two following species—*Anemonia sulcata* (36, 36, 36, 72) and *Ilyanthus Mitchellii* (18, 18)? What is the type of *Aureliania angusta*, of which the marginal series is composed of 42 tentacles? *Palythoa Couchi* has, according to my observations, 2 cycles of 14–15 tentacles. Mr. Gosse attributes to it 24 tentacles (12, 12) in the young, and 28 (14, 14) in the adults, which would prove that at one time this species is a Hexactinia.

These facts make one think that, in the zoological group of the Actiniæ, the number of tentacles has not the value that has been attributed to it. The type has not even the importance of a generic character, since in the genera *Sagartia*, *Phellia*, *Halcampa*, and *Edwardsia* certain species have 8, and others 12 tentacles and their multiples.

The variability of the number of tentacles is explained by the embryogeny of the Actiniæ, the embryo having successively 4, 6, 8, 10, and 12 dissepiments and tentacles. By assuring an arrest of development at each of these periods, we obtain the various types which correspond to them ; and in certain species the normal combination of the two types (*Edwardsia carnea* and *Corynactis viridis*) faithfully represents the normal development of a Hexactinia, which passes from 8 to 12 dissepiments and tentacles. Seeing how much the tentacular type varies in the Actiniæ, one may also doubt the importance of the number of systems and cycles in the Corals.

\* In the same way *Sagartia sphyrodeta* has 5 cycles (8, 8, 16, 32, 64) on our coasts, and 4 cycles in England (8, 8, 16, 16), according to Gosse.

† L. Agassiz has discovered in America a species (*Rhodactinia Davisi*) of the same type. Its embryos have 10 tentacles only.

Nevertheless I am struck with this circumstance, that the rugose Corals, with a tetrameral type, are hardly ever found, except in the transition-rocks: they therefore preceded the secondary Corals of the hexameral type, just as in the embryos of our living Actiniae we see appear 4 and then 6 tentacles. The history of the organisms on the surface of the earth consequently resembles the development of an existing animal.

Some species of the Actiniae seem to be reproduced with the greatest facility by means of little fragments abandoned by the foot. I have ascertained this process of multiplication in all the individuals of *Sagartia pellucida*\* that I kept in captivity in 1872 and 1874. Diequemare discovered the strange fact in *Mitridium dianthus*.

Spontaneous scissiparity is, on the contrary, the most common mode of propagation in *Sagartia ignea*. I have observed it also in *Anemonia sulcata*†. It never takes place in *Sagartia effata*, and in many other species which I have examined. The tendency to scissiparity and to reproduction by means of the fragments of the foot would have nearly the value of a specific character.—*Comptes Rendus*, November 23, 1874, p. 1207.

#### *Action of Light on the Development of the Young of Frogs.*

M. Thury took the eggs of *Rana temporaria* and placed them all under precisely the same favourable circumstances, except that while part received light through colourless glass, another part received it through green glass. The former developed rapidly, and by the end of May had a length of four centimetres, and well developed hind legs in most of them; while the latter were slowly developed, blackish in colour, hardly had a length of two centimetres by the end of May, and were without a trace of the hind legs. By the 10th of June the former had their fore legs and some were changed to frogs; the latter, still black, had no trace of legs, and breathed almost exclusively by means of their gills. By the 15th of July all the former had become frogs; but those of the latter still had no legs, and by the 2nd of August they were all dead without a trace of legs having appeared. Some of the young of the latter lot, transferred to the vessel of the former on the 15th of July, finished their metamorphosis. At the same time some of the former transferred to the vessel containing the latter continued to develop, showing the influence of the first impulse in their development.—*L'Institut*, Dec. 23, 1874.

\* On the 23rd of August, 1872, a *Sagartia pellucida* abandoned about ten fragments of the foot; on the 25th of August they became rounded; on the 5th of September one of them bore 8 tentacles; on the 7th of September the same fragment presented 15 or 16 tentacles.

† On the 18th of September, 1874, an *Anemonia sulcata* divided spontaneously, brought together its divided integuments; on the 21st of September the new-formed disk spread out, and the rudiments of the new tentacles were seen; on the 28th of September there were 20 tentacles.

# THE ANNALS

AND

## MAGAZINE OF NATURAL HISTORY.

[FOURTH SERIES.]

No. 90. JUNE 1875.

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XLVII.—*On two Hexactinellid Sponges from the Philippine Islands in the Liverpool Free Museum.* By THOMAS HIGGIN, of Huyton. *With Remarks by H. J. CARTER, F.R.S. &c.*

[Plates XXI. & XXII.]

THE sponges a brief description of which is now given were lately purchased, together with some examples of *Meyerina clavaformis* and *Rossella philippinensis*, by Mr. S. T. Martin, of Altringham, from the friends of an English resident at Cebu, and by his kindness and liberality have now been added to the collection in the Liverpool Free Museum. They are said to have been obtained by diving, and therefore, if this was the case, were probably procured at a depth not exceeding 10 fathoms. One of them is a *new* species of the genus *Hyalonema*, which it is proposed to name after the island from the neighbourhood of which it was obtained. The other is a fine specimen of *Labaria hemispharica*, Gray, in very good condition, and, having the anchoring-spicules *in situ* and the base perfect, affords an opportunity of settling the doubts which have hung around the first example brought to this country (by Dr. Meyer). Both were sent to England in a dry state.

*Hyalonema cebuense*, n. sp., mihi. Pl. XXI. fig. 1.

In general form the sponge resembles a sculptor's mallet which has become indented on its sides by repeated blows  
*Ann. & Mag. N. Hist.* Ser. 4. Vol. xv. 27

on the head of the chisel, the handle being represented by a twisted rope-like anchoring appendage. The colour is light sponge-yellow. The dermal surface, now entire only on the lower half of the sponge, consists of a latticework, generally of a light grey colour, following the gentle undulations of the exterior of the mass, and is entirely "pore-area." There are no "vent-ridges" as in *Meyerina claviformis*; but at the top of the sponge is an irregular funnel-shaped cloacal orifice communicating with cavities in the centre of the mass. The glass-rope-like anchoring appendage has been imbedded for half its length in the sandy bottom of the sea, has a strong spiral twist, issues from the sponge as a cord, and, cord-like, passes up through fully two thirds of the head. The latticework of the surface is covered by a sarcodic investing membrane, pierced with pores over the interstices, which pores are bordered by the arms of a little dermal spicule (to be more particularly described hereafter) whose points touch each other, thus forming a lesser latticework within the interstices of the larger one. The pores thus situated lead at once into the general canal-system, which consists of very large and small passages, usually with rather thin walls, and having an areolar appearance. Some of the large canals take a vertical course towards the depression at the top of the sponge; others run directly across it into the central cavities; but all communicate directly or indirectly with these cavities—which are more or less ovate in form, and extend up and down the sponge round the cord or fixed end of the anchoring rope.

The spicules composing the glass rope are of one kind only, 12 to 14 inches long, and fusiform. The fixed end of this spicule or that part within the sponge, is smooth; and the surface of the free portion is also smooth for half or two thirds of its upper part; but after this it begins gradually to present what appears to be a broken spiral line, which by degrees becomes wider. Soon the line becomes a ledge, the perpendicular margin of which looks towards the sponge; and on the ledges are found thin pointed flat spines or teeth standing up side by side in a row or line. By degrees the ledges carrying many teeth subside into brackets carrying a single spine only, when the spicule has an undulating or sinuous appearance for a short distance and finally a short, smooth, straight portion, when, having reached its greatest amount of attenuation (viz. about 1-400th of an inch in diameter), it again gradually swells out to 1-300th of an inch, and then ends in a small, thick, conical or mitre-shaped head, with four short round arms, recurved and opposite or at right angles to each other, the

head (including the arms) being about as broad as long, viz. 1-150th of an inch (fig. 9)—that is, about three or four times less in diameter than the thickest part of the shaft, which is much nearer the free than the fixed end.

The spicules of the latticework (fig. 2) are of three kinds:—1, a strong five-rayed or nail-like form, consisting of a vertical shaft pointed at one end, and carrying at the other four rather long, robust, horizontal arms at right angles to the shaft and to each other; the shafts of these spicules are fixed in the general sponge-mass vertically; and the arms of each extend towards, meet, and overlap those of others horizontally, thus forming the square-shaped meshes of the larger latticework; 2, long, slender, fusiform, acerate spicules, which lie upon the arms of the large nail-like forms longitudinally, and help to strengthen the lines of the latticework; 3, small crucially headed spicules of the nail-like form, the shaft of which is much longer than the arms of the head, and furnished all round throughout the greater part of its length with long spines, which are bent obliquely outwards and extend to the pointed end, giving the whole a plumose appearance; the arms, which are nearly smooth, are pointed, opposite, and at right angles to the shaft and to each other (fig. 8). These spicules are generally found in pairs, with the shafts close together and the arms obliquely crossing each other as they rest upon those of the large nail-like spicules; also throughout the areas of the large meshes, where their nail-like heads are fixed in the dermal membrane, with the common shaft standing outwards, and the points of the arms touching those of their neighbours, so as to divide the large meshes of the latticework into a number of smaller ones, each of which is converted into a round hole or pore by the dermal sarcode.

But amongst the spicules of the surface must be mentioned a very large, stout, acerate spicule, closely resembling that found by Mr. H. J. Carter in the stem of *Crateromorpha Meyeri*, measuring in its average largest size about 4-12ths of an inch in length by 1-66th at its broadest part. It is occasionally found under the arms of the large nail-like spicules, but generally together with long slender acerates (both smooth and spined), composing strong fibrous lines, which contribute to support the latticework and to connect it with the general sponge-mass (Pl. XXII. fig. 1).

The spicules of the general structure are:—1, large and small nail-like forms, with smooth shafts and arms; 2, long, slender, smooth, fusiform acerates; 3, the same, with four large tubercles on the middle of the spicule, or abortive rays; 4, long, thin, fusiform-acerate, thickly spined throughout, the

spines bent, and all pointing towards one and the same end of the spicule; 5, fusiform-acerate, sparsely spined throughout, but the spines on *each* half pointing respectively towards the *middle* of the spicule (Pl. XXI. fig. 3); 6, the large stout, smooth acerate (whose measurements have just been stated), conspicuous from its great size amongst the other forms with which it is associated (Pl. XXII. fig. 1); 7, slender, smooth, crucial or four-armed spicules, the arms horizontal and at right angles to each other; 8, similar-shaped spicules, larger than the last named, but barbed harpoon-like towards the ends of the arms (Pl. XXI. fig. 4); 9, small sexradiate forms furnished with rather long spines, which commence about half-way along the rays, shooting out in the direction of their points and bent upon themselves outwards (fig. 5); 10, a nail-like form with short straight arms and long plumose shaft, spines rather short; 11, large eight-armed birotulates, about 1-90th of an inch in length, with dome-shaped heads and four or eight tubercles, chiefly confined to a ring round the middle of the shaft; 12, a small eight-armed birotulate of slender form, about 1-225th of an inch in length (fig. 6), the shaft of which is studded throughout with short obtusely pointed spines, the heads not dome-shaped but pointed; 13, a very minute birotulate, averaging 1-1250th of an inch in length, having the appearance of bearing only two arms at each end (fig. 7), but, when carefully focused endwise, is seen to be multihamate, the normal number of its arms being probably eight, though in some instances six only can be counted, whilst in others ten may be seen, the shaft spined more or less throughout, and the heads dome-shaped; this minute spicule is found in great numbers in the dermal sarcodite, as well as generally throughout the sponge.

The long fusiform-acerate spicules form the fibrous lines of the general structure, on which are seen the large birotulates and the long-shafted plumose forms; whilst the crucial spicules are found in the sarcodite of the walls of the canals. Most of the acerate forms are of the sexradiate type, as is evident from the cross in the central canal in the middle of the spicule; but the main shaft only is produced, the arms either not being produced at all or appearing only as tubercles.

The spicules of the sponge immediately embracing or surrounding the glass rope where it issues from the mass are several varieties or modifications of the sexradiate type. There is no Polype on the rope, nor any membranous covering of any kind. The sponge-head is grooved inwards circularly round the rope, as a pear often is round the stalk; and the plumose spicules of the dermal latticework can be traced close up to the

rope, which is there surrounded by an irregular line of closely packed, small, sexradiate spicules interspersed with plain and tubercled acerates. The form most noticeable here is a crucial-shaped spicule (Pl. XXII. fig. 2), the arms of which measure about 1-100th of an inch in length, straight or more or less bent towards the extremities, and closely studded near the points with short, obtusely pointed, vertical spines, which appear to represent the "*cylindro-cruciform*" spicules of *Hyalonema Sieboldii* figured by Dr. Bowerbank (B. S. vol. i. p. 252, pl. vi. figs. 153-156), the "*spiniferuces*" (?) of Brandt. Another prominent spicule is the smooth-armed nail-like form, and the same furnished near the ends of the arms with short obtusely pointed spines. There are also many extremely slender long-armed crucial and six-rayed spicules, with the arms of varying lengths, sometimes smooth and sometimes furnished sparingly with long spines bent in some instances towards the points, in other cases towards the base of the arms. There is also a development of the four-armed plumose spicule into the sexradiate form, another shaft opposite the plumose one being projected, rather longer than the other, and thickly studded, like the crucial arms (which are nearly as long as the plumose shaft), with short obtusely pointed spines: sometimes also this form occurs with only two of the crucial arms produced. The minute birotulate, too, is very numerous here.

The height of the sponge, measuring from the part from which the anchoring rope issues, is about  $5\frac{1}{2}$  inches, its breadth is about  $4\frac{3}{4}$  inches; and the length of glass rope visible is nearly 10 inches, with a diameter of  $\frac{1}{2}$  an inch close to the sponge.

*Hab.* Marine.

*Loc.* Cebu, Philippine Islands.

*Obs.* The fact of the sponge having lost the latticework covering on its upper half, and the canal-system being in consequence either exposed or covered with a matted mass of spicules, led at first to the inference that it had become detached from the sea-bottom, and had either been cast up on the shore or had been rolling about for some time on its sides, and had so accumulated the matted mass from without. But when it was found that the mass contained only the spicules of the species, it appeared unlikely that it had been so gathered up; for if the sponge had been rolling about on the sea-bottom, the matted part would probably have contained a number of spicules belonging to many other sponges. On consulting Mr. H. J. Carter, F.R.S., who has been most kind in expressing his opinion on this sponge, in pointing out different points of special interest, and in reviewing and discussing the

observations made with the view of establishing them, and so very materially helping in the description, he suggested what appears to be the true solution of the difficulty. He accounts for the existence of the matted mass by finding that the sponge has been attacked by a *Mucor*-like fungus, which has been gradually destroying the sarcode and eating into the sponge-substance; and as the sarcode has disappeared, the spicules losing their natural support have fallen together into the matted mass, which in this state now covers over much of the upper portion of the sponge. Although the specimen is thus rendered imperfect so far as the entirety of the latticework goes, it is nevertheless highly interesting as showing the ravages of the parasitic fungoid growth, whose mycelium is found in great quantity not only on the surface, but gradually extending into the mass, and spreading everywhere its bright little sporules in extreme abundance.

The sponge itself, again, is interesting on account of the glass rope being without its usual parasite, viz. the incrusting Polype (*Polythoa*), which is still held by a few persons to be a part of the sponge (its "oscula"!), and by some to belong to the glass rope, on which they say the sponge is parasitic—in opposition to the more generally received impression, now confirmed by this specimen, that the glass rope is the stem or anchoring appendage of the sponge, upon which the Polype is parasitic.

The twisted stem or glass rope is almost identical with that of *Hyalonema Sieboldii*: the surface of the spicules composing it hardly differs except towards the lower part, where the difference is only sufficient to indicate a variety; while the anchoring head or termination is of the same character—namely, mitre-shaped with four opposite arms. The free ends, however, of these spicules in the Japanese specimens are generally broken off; but an example exists in the Liverpool Free Museum (no. 10. 9. 68. 1) in which many of the terminations remain; and Mr. Laurence Hardman, of Rock Ferry, also has a specimen, received last year through his son from the island of Inosima, in which the free ends are in a tolerably perfect condition. In the latter example these spicules terminate, as in *H. cebuense*, in four short, bluntly pointed, rounded arms, recurved and opposite, or at right angles to each other, the head and arms being about as broad as long, and measuring 1-170th of an inch. In the Liverpool-Free-Museum specimen, however, the terminations, although of the same character, present modifications of the four opposite arms: that is to say, sometimes four rather shorter arms appear between the four principal arms, making eight arms in all; sometimes just above the four arms on the smooth shaft are



prominences or swellings, which again (as in fig. 10) are so developed as to form a double set of four arms, one set capping the other. The Liverpool-Museum specimen bears the usual Polype; the Inosima example, in which the glass rope is short, has *no* Polype on it.

The existence of the large stout acerate spicules in the surface-structure of *Hyalonema cebuense* is a noticeable feature; similar spicules quite as large are found in the Japanese *Hyalonemas*—not on the surface, however, but, together with other acerate spicules, forming the fibrous lines of the general internal structure, being probably most numerous round the fixed part of the stem.

It is interesting to notice the relationships which seem to exist between the various kinds of Hexactinellid sponges, as shown in the peculiar forms of spicules differently developed in some, appearing in greater or less quantities in other species, and occupying different positions in the general structure of the different sponges, but which would perhaps occupy too much space to describe in detail here. All such observations, however, lead to the conclusion that the peculiar features of the various anchoring appendages, adopted by Mr. H. J. Carter as the means of distinguishing genera, are the most remarkable and most easily noticeable for this purpose.

#### Remarks by MR. CARTER.

In bringing to notice *Hyalonema cebuense*, Mr. Higgin has described and illustrated a sponge which, if not sufficiently different from *Hyalonema Sieboldii*, Gray, to constitute a new species, is at least deserving of the separate designation which has been given to it.

Here we have, in the first place, a full-grown *Hyalonema* with an entire absence of the parasitic Polype which usually corticates the upper part of the cord!

We have also obtained through it the free termination of the anchoring-spicule of which the cord is composed in the *Hyalonemata*, which was previously unknown; and moreover Mr. Higgin has shown that in both *Hyalonema Sieboldii* and *H. cebuense* the principle of formation is the same, viz. a mitre-shaped inflation with four spines or arms recurved and opposite: also in Mr. Hardman's specimen, to which Mr. Higgin has alluded, it is stated to be four-armed opposite, the same "as in *H. cebuense*;" while the Polype, too, is absent from the cord of this specimen. But it so happens that the specimen which Mr. Higgin kindly sent me of an anchoring-spicule from this cord had *eight* arms or spines each opposite each

other on the mitre-shaped inflation of the head, and not four above and four below, as delineated by Mr. Higgin (Pl. XXI. fig. 10) from the specimen of *Hyalonema Sieboldii* in the Liverpool Free Museum. This shows that, besides *four* arms recurved and opposite on a mitre-shaped inflation being the principle on which the head of the anchoring-spicule is formed generally in the *Hyalonemata*, it is subject to the modifications mentioned in all these specimens.

As regards the bearing of this "principle of formation" on the termination of the anchoring-spicules of the genus *Rossella*, in which there are also four opposite arms, it will be seen by comparing the two that there is no "inflation" in *Rossella*, but the arms come off from the end of the spicule directly; also that the diameter of the head, taken in its entirety, is far greater than that of any part of the shaft—which is the opposite in *Hyalonema*, in which the so-called "arms" are little more than spines, while in *Rossella*, from their size and length, they are really "arms;" lastly, that the shafts of the anchoring-spicules in the genus *Rossella* are not spined, but *smooth*.

The large "birotulate, no. 11," p. 380, appears to be the full-grown size of the minute or embryonal one "no. 13," as evidenced by gradationary development in a fragment of *Hyalonema Sieboldii* mounted in Canada balsam; while the differences in form do not amount to more than modifications of the normal type—consisting of a shaft, and eight arms opposite and recurved, all round each end; which arms being knife-shaped with their thin edges respectively extended into a falcate form towards the shaft, with which they are thus united, constitutes this flesh-spicule the representative among the Hexactinellid sponges of the common equianchorate.

The "spinicruces" of Brandt, so well figured by Dr. Bowerbank (Brit. Spong. vol. i. pl. vi. figs. 153–157, p. 252), have their representatives, as stated by Mr. Higgin (p. 381), in the crucial spicules with spined extremities, so abundant just where the sponge-head joins the cord in *Hyalonema cebuense* (Pl. XXII. fig. 2).

They are similarly situated in *H. Sieboldii* and in *H. lusitanicum*; but we do not find that they extend upwards further than this.

In some very small specimens of *H. lusitanicum* dredged up off the Butt of the Lewis on board H.M.S. 'Porcupine' both with and without the Polype, these spicules are equally abundant at the point mentioned; while the cord in *H. lusitanicum*, not stopping halfway up the sponge-head as in *H. Sieboldii*, but passing entirely through the head so as to

end at the summit in a little conical point, affords ample opportunity in *H. lusitanicum* to search for the "spinieruces" throughout its whole length within the sponge-head; for it is covered, even to the end of the "conical point," with the sponge-structure, especially the little dermal plumose spicule, though I cannot detect the "spinieruces" in any part of the cord or sponge-head *above* the place indicated.

Moreover, where the Polype is present, it is the sarcodic layer immediately in contact with the cord which is so densely charged with those beautiful little spined sexradiates, and which, in some instances, evidently extends downwards *beyond* the integument of the Polype; so that altogether the Polype must be considered to have no part in their production, while the "spinieruces" must therefore be viewed as the hexactinellid form of spicule (with its variations) peculiar to the sarcodic investment of the cord.

*Labaria hemisphaerica*, Gray. Pl. XXII. fig. 3.

This species has already been described by Mr. H. J. Carter ('Annals,' 1873, ser. 4, vol. xi. p. 275), from the sponge named by the late Dr. J. E. Gray in his communication published in the same volume at page 235. Mr. Carter, however, soon became aware that the specimen placed in his hands for description was not in its natural state; and the discovery that the brush-like appendage apparently growing out from the centre of the base had been artificially placed there, and was made up of spicules belonging to quite another species, led him to think that the whisker-like spicules standing out from the sides of this specimen of *Labaria* were probably also a native's fancy. It is fortunate therefore that a good specimen has now been brought to this country, with the anchoring-spicules *in situ*, and without the "fraudulent tuft" which the British-Museum sponge possesses. In Mr. Carter's description, the "locality" whence Dr. Meyer's sponge was obtained is thus stated, viz. "Unknown, from Singapore;" but it was subsequently observed by Dr. Meyer ('Annals,' 1874, ser. 4, vol. xiii. p. 66) that it was procured "from the reefs in the sea near the village of Talisay, on the island of Cebu, Philippine Islands;" and in explanation of the artificial condition of the sponge, in a letter to Dr. Gray (*ibid.* p. 188), he explains that his "Malay boy was charged with the business," and that "he or the fishermen may have done the mischief." Dr. Meyer does not seem to have been present when the specimen was got up; but he adds that it was obtained from the same ground as "*Meyerina claviformis*, *Crateromorpha Meyeri*, and *Rossella philippinensis*."

As regards the present example, the only information given is that it was obtained by diving, off the island of Cebu; but it is in a natural state, and has not been tampered with like the British-Museum specimen.

In form it is like a small bird's nest the bottom of which is flat, with a well-defined edge; the sides are rounded; and the sponge attains its greatest diameter about one third of the way down from the edge of the hollow of the nest, towards the base. The entire surface, inside and outside (speaking as of a nest), is a network of spicules: that of the sides of the nest, being a close reticulation, is no doubt "pore-area;" whilst that of the hollow of the nest is a very much more open network, and must be considered "vent-area," as has been stated by Mr. H. J. Carter in the paper to which I have already alluded. The structure covered by the surface-reticulation, as seen through this network, is a strongly woven-together mass of spicules, pierced with large and small passages leading directly from the outside to the inside. These passages or canals are largest towards the base of the sponge, where they are ovate in form, and measure in diameter half an inch by a quarter; they gradually diminish in calibre and lose their oval shape, becoming circular towards the upper edge of the nest. The surface-reticulation is closest round the edge of the hollow; and from this edge stands up a thin broken line of erect spicules of irregular height, varying from  $\frac{1}{4}$  to  $\frac{3}{4}$  of an inch. The rounded sides of the sponge, chiefly where it assumes its greatest diameter, are furnished with whisker-like bundles of long spicules, which issue from circular holes the edges of which are slightly raised, each bundle consisting of a dozen or more spicules, many of which are broken short off and very few are entire. Around the circumference of the base are arranged loose fascicles of anchoring-spicules from 3 to 4 inches in length and having a diameter of about  $\frac{1}{2}$  an inch measuring along the edge of the base, by  $\frac{1}{4}$  to  $\frac{3}{8}$  of an inch across it. A few scattered short spicules project here and there from the base generally; but there are no bundles other than those around its edge; and therefore the sponge is without any thing like the "fraudulent tuft" stuck into the British-Museum specimen, or occupying its position. The bundles of anchoring-spicules, whilst the sponge was in a living state, no doubt grew straight down from its base into the bottom of the sea; but they are now twisted under it, in consequence of the sponge having been placed to dry in the position in which it appears in the Plate.

The anchoring-spicules are of one kind only, viz. smooth, fusiform, terminating at the free end in two opposite hooks;

there are *no* spined forms, from which it must be inferred that the spined anchoring-spicules noticed by Mr. Carter in his description of the British-Museum sponge belonged to a "*Meyerina clavaformis*," as well as the bunch of spicules forming the "fraudulent tuft," and had been caught up accidentally, if not purposely stuck on to the specimen. The smooth anchoring-spicule which is the one proper to the species is a fine hair-like spicule, 3 to 4 inches in length; it tapers from its middle to a fine point at its fixed end, and also gradually diminishes to within a short distance of its free end, measuring there only 1-1000th of an inch, after which it quickly becomes flat, with a breadth of 1-300th of an inch, and ends in two opposite hooks, recurved like the flukes of an anchor, as figured by Mr. Carter ('Annals,' 1873, ser. 4, vol. xii. pl. xiv. fig. 2), the entire spread of the anchor measuring 1-45th of an inch (Pl. XXII. fig. 3 A).

The spicules of the whisker-like tufts are plain, fusiform, in length about  $3\frac{1}{2}$  inches, with a diameter of 8-500ths of an inch at the middle or thickest part.

The spicules of the erect fringe round the labrum, all more or less broken at the free end, are also fusiform, and, as they exist at present, are smooth throughout; but there is an appearance of spines on some towards the free end, and therefore in their perfect state they may perhaps be furnished with short conical spines towards the points. The largest are about one inch long, with a diameter in the middle of 1-750th of an inch.

The spicules of the surface-reticulation are of four kinds:—  
1, large nail-like spicules (that is, smooth pointed shafts) with four equally smooth arms projecting opposite or at right angles to each other from the heads of the shafts, the arms inclined slightly downwards or inwards; these spicules are of various sizes, from the large form, plainly visible to the unassisted sight, down to others of microscopic minuteness; the shafts of the larger spicules are  $\frac{1}{2}$  an inch in length; the arms may be the same, but most frequently they are of different lengths; and sometimes one of them is blunt, not at all pointed, and not more than 1-12th of an inch long; the shafts and arms measure at the cross about 1-48th of an inch in diameter;  
2, long, slender, acerate spicules, thickly covered with short sharp spines, all pointing towards one and the same end of the shaft;  
3, smooth acerates, with the cross on the central canal;  
4, plumose spicules of shapes intermediate between one with a very thick shaft, short and bushy-looking, with long, strong, bluntly ended arms (Pl. XXII. fig. 5), and another with small, short, fine arms and a long feather-like

shaft (fig. 7); the crucial arms of which, thickly studded with short obtusely pointed spines, are bent downwards, as if to embrace or fit to the arms of the large spicules on which they rest.

The strongly woven-together basketwork of the interior, as seen through the investing network, is composed of:—smooth spicules of the sexradiate type (that is, acerate with simply a central cross indicating their hexactinellid character); acerate, with four tubercles at the middle of the shaft; sparsely spined acerates, the spines bent towards the middle of the spicule; four-rayed, five-rayed, and six-rayed spicules, the long arms of which are bent together in all varieties of ways; amongst these are large and small eight-armed “birotulates” with dome-shaped heads, and some very minute ones; small sexradiate spicules, the arms of which are furnished towards the free end with three, four, or five long spines projecting in the direction of the free end of the arm, but soon becoming bent outwards (fig. 14); also a small acerate spicule in great abundance peculiar to the species, furnished with fine spines not very close together, all of which are bent towards one end of the spicule, increasing in length along one third of the spicule (viz. from the end *from* which they look), and then gradually diminishing again from this point to the other end of the shaft (fig. 11); and plumose spicules in great variety.

Size:—extreme transverse diameter  $4\frac{1}{2}$  by 4 inches; depth  $3\frac{1}{4}$  inches; diameter of hollow at the labrum  $3\frac{1}{2}$  by 3 inches; depth of hollow  $1\frac{1}{2}$  inch; diameter of base 3 by  $2\frac{3}{4}$  inches; length of bundles of anchoring-spicules 3 to  $3\frac{1}{2}$  inches.

*Hab.* Marine.

*Loc.* Cebu, Philippine Islands.

*Obs.* The position of the large smooth nail-like spicules is readily seen in the figure, which is drawn from a photograph of the sponge; and the elevations and depressions on the surface, caused by their arms being slightly bent inwards towards the shaft, are also easily observed. The large areas enclosed by the arms of these large spicules crossing each other are subdivided again and again by smaller spicules of the same form; and the fine network so caused has no doubt supported the dermal sarcode, stretched membrane-like upon it and pierced with pores. But this sarcode does not now exist in this membranous form, having apparently contracted round the lines of spicules forming this dermal reticulation, and thus left holes bordered by spicules, which were filled up by pores respectively circumscribed by sarcode. The plumose spicules are all seen about the lines of the network; and if they have ever rested

on the membranous sarcode, as in the British-Museum specimen (in the way described by Mr. Carter), they have been drawn in to the arms of the other spicules by the contraction of the sarcode.

*Remarks by MR. CARTER.*

The specimen of *Labaria hemisphærica* above described and figured by Mr. Higgin is fortunately so well preserved that there can be no doubt of its being in a natural state, viz. unaffected by destructive influences or tampering of any kind, as that which I described belonging to the British Museum ('Annals,' 1873, ser. 4, vol. xi. p. 275); hence it serves well to correct that description.

That "cat's-whisker-like" groups of spicules do project from the sides of *Labaria hemisphærica* as *normal* appendages there can now be no doubt; and that the anchoring-spicules with *spined* shafts are *abnormal* may be inferred from their entire absence in Mr. Higgin's specimen. We must therefore conclude that the latter belonged to the "fraudulent tuft" of anchoring-spicules from *Meyerina clavæformis*, which had been thrust into the base of the British-Museum specimen. And for this I am well prepared, seeing that in my figures of the *supposed* anchoring-spicules with spined shaft from *Labaria hemisphærica*, and the *real* one from *Meyerina clavæformis* respectively that I have figured ('Annals,' 1873, vol. xii. pp. 467, 468, pl. xiv. figs. 1 & 3), it is stated and shown that the differences between these two spicules are "too slight for specific distinction."

Further, it now appears to me that, while the shafts of the anchoring-spicules of *Labaria hemisphærica* and of the genus *Rosella* are *all* smooth, those of *Hyalonema* &c. are *all* spined; and that the latter only appear to be sometimes smooth from the spines being continued upwards from the free end for a less distance in some than in others, whereby when the spined ends are broken off (which is often the case) there is an appearance of two forms, viz. one spined and the other smooth. Hence the mistake.

EXPLANATION OF THE PLATES.

PLATE XXI.

Fig. 1. *Hyalonema cebuense*, Higgin, after a photograph by Robinson and Thompson, rather less than half the actual size: *a*, the investing latticework; *b*, portion denuded of the latticework, which has been destroyed by a parasitic fungus attacking the sarcode which supported and connected the spicules.

- Fig. 2.* Portion of dermal latticework, showing the relative position of the spicules of which it is composed: *a a a a*, arms of large nail-like spicule; *s s s*, shafts of the same; *d*, sarcode stretched across the mesh; *p*, pores; *c*, feathered spicules (no. 8) *in situ*. Diagrammatic.
- Fig. 3.* Sparsely spined acerate spicule, the spines pointing towards the middle of the spicule.
- Fig. 4.* Crucial spicule, with points of arms barbed like a harpoon.
- Fig. 5.* Small sexradiate spicule, the arms spined towards their extremities; the spines bent upon themselves, pointing towards the ends of the arms.
- Fig. 6.* Slender birotulate with eight arms at each end, the shaft studded with short blunt spines throughout its entire length.
- Fig. 7.* Minute birotulate generally with eight arms at each end, in great quantities throughout the sponge.
- Fig. 8.* Crucially headed plumose spicule of the latticework.
- Fig. 9.* Free end of one of the spicules of the glass rope.
- Fig. 10.* Free end of one of the spicules of the glass rope of a Japanese *Hyalonema*, in the possession of the Liverpool Free Museum (no. 10. 9. 68. 1).

## PLATE XXII.

- Fig. 1.* Large acerate spicule from surface of *Hyalonema cebuense*, similar to that found in the stem of *Crateromorpha Meyeri*; it is also found in *Hyalonema Sieboldii*, not, however, on the surface, but in the interior structure round the cord. It measures about 4-12ths of an inch in length by 1-66th in its broadest part.
- Fig. 2.* "Spinierucial" spicule from base of sponge-head of *Hyalonema cebuense*, in great quantity about the cord; length of each arm 4-500ths to 5-500ths of an inch.
- Fig. 3.* *Labaria hemisphærica*, Gray, after a photograph by Robinson and Thompson.
- Fig. 3 A.* Anchoring-spicule of *Labaria hemisphærica*, drawn to the scale of 1-500th to 1-8th of an inch.
- Fig. 4.* Large nail-like spicule from the surface-reticulation of the same. Shaft  $\frac{1}{2}$  an inch in length, with a diameter of 1-48th of an inch at the head; length of arms  $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{4}$ ,  $\frac{1}{3}$  inch respectively.
- Figs. 5-7.* Plumose spicules, extreme forms, there being many varieties of intermediate shape; measuring from 2-500ths to 10-500ths of an inch in height or length of plumose shaft.
- Figs. 8-14.* Some of the spicules of the general structure: 8, 9, 10 measure on an average 1-10th of an inch in length; 11 is peculiar to the species, and measures generally 8-500ths of an inch in length; 12 and 13 are drawn to the scale, viz. 1-500th to 1-8th of an inch (13 supposed to be an immature form of 12); 14 measures 3-500ths of an inch from the point of one arm to the point of the arm opposite.



XLVIII.—*Descriptions of some new Asiatic Species of Rhynchites.* By FRANCIS P. PASCOE, F.L.S. &c.

It is chiefly from the collection made by Mr. Wallace that I have selected the following well-marked species of *Rhynchites*. The genus was separated from *Attelabus*, Linn., by Herbst in 1797, and comprises about 100 species, including those here described; it is almost cosmopolitan, but has not yet been found in Australia. M. Roelofs has lately described several new species from Japan; and I have here added another (allied to *R. betuleti*) which is also found there (Yokohama), although it does not seem to have been met with by Mr. Lewis's collectors.

*Rhynchites elysius.*

*R. læte cæruleus*, sparse albido-pilosus; rostro (♀) corporis dimidia longitudine, modice arcuato, vage punctulato, dimidio basali tricarinato; (♂) brevior et manifeste crassior, infra angulis exterioribus utrinque fortiter quinquedentatis; antennis haud elongatis, articulis 3<sup>o</sup>, 4<sup>o</sup> æqualibus; clava magna, grisea, art. duobus basalibus triangularibus, singulis latitudine haud longioribus, ultimo ovato, acuminato; prothorace latitudine haud longiore, sat vage punctulato; clytris amplis, striato-punctatis, punctis approximatis, interstitiis sat confertim punctulatis; tibiis costulatis. Long. 4 lin.

*Hab.* Sumatra.

Allied to two species known as *R. philippensis*, Chev., and *R. cælestinus*\*, Gyll., but at once distinguished from both by the sparse punctuation on the prothorax. *R. azureus*, Ol.†, is a very distinct species, hitherto overlooked, except that it is doubtfully cited as a synonym by Gyllenhal for his *cælestinus*.

*Rhynchites alcyoneus.*

*R. cæruleus*, clytris violaceis, albido-pilosus; rostro tenui, corporis longitudine vix dimidia, modice arcuato, haud carinato, basi inter oculos compresso; antennis haud elongatis, articulo tertio quam quarto paulo longiore, clava concolori, art. duobus basalibus elongato-triangularibus, ultimo anguste ovato, acuminato; prothorace

\* There is some confusion in the synonymy here. Taking Lacordaire's note (Gen. vi. p. 555) as correct, the following would be the chronology:—

*Rhynchites cælestinus*, Gyll., 1833.

— *grandis*, Imhoff, 1838.

— *philippensis*, Chev., 1841.

Yet Lacordaire, adopting the two latter names, gives the first as a synonym for both.

† Ins. v. no. 81, p. 23, pl. ii. fig. 32. My specimens are from Singapore and Sumatra.

latitudine haud longiore, sat vage punctulato; elytris modice ampliatis, seriatim punctatis, punctis rugosis, punctisque minusculis sat confertim interpositis; tibiis costulatis. Long.  $3\frac{1}{4}$  lin.

*Hab.* India.

Like the preceding, but smaller, and the elytra very moderately dilated, with fewer punctures; the rostrum and antennæ are radically different. *R. azureus* is a narrow species, with a more slender club &c.

*Rhynchites hispidus.*

*R. rufo-luteus*, nitidus, elytris nigris, pilis erectis nigris vestitus; capite sat lato, subquadrato; rostro prothorace vix longiore, basi bisulcatulato, apicem versus sensim fortiter dilatato; antennis nigris, articulis duobus basalibus subcylindricis, cæteris crassis, oblonge (quinto ad octavum æquilateraliter) triangularibus; clava elongata, articulis oblongo-ovatis, præcedentibus haud crassioribus; prothorace subtransverso, utrinque rotundato, antice posticeque constricto, apice quam basi vix angustiore; elytris grosse punctatis, punctis basin versus minoribus; corpore infra pedibusque luteis; tibiis integris. Long. 2 lin.

*Hab.* Penang.

Like a *Hispa*, with the coloration of *Gonophora hæmorrhoidalis*, Fab.

*Rhynchites lævigatus.*

*R. glaber*, purpurascens-niger, elytris subchalybeatis; capite impunctato; rostro subvalido, modice elongato, perparum arcuato, sat vage punctulato, basi carinula abbreviata utrinque munito; oculis haud prominulis; antennis mediocribus, articulis tertio quartoque æqualibus, longioribus, sequentibus gradatim brevioribus et latioribus, ultimo æquilateraliter subtriangulari; clava lata, articulis duobus basalibus transversis, ultimo conico; prothorace oblongo, subconico, sat vage subtiliter punctulato; scutello valde transverso; elytris tenuiter striato-punctatis, interstitiis planatis, subtiliter parce punctulatis; corpore infra remote subtilissime punctato; tibiis integris. Long. 3 lin.

*Hab.* Menado.

Another specimen from the same island has the prothorax and metasternum much more strongly punctured.

*Rhynchites gagates.*

*R. glaber*, niger, nitidus; capite impunctato; rostro sat tenue, longitudine prothoracis cum capite, dimidio basali supra fortiter bisulcato et in medio carinato, dimidio apicali ruguloso-punctato; oculis haud prominulis; antennis breviusculis, articulis 3<sup>o</sup>, 4<sup>o</sup>, 5<sup>o</sup> æqualibus, sequentibus gradatim brevioribus et latioribus; clava

lata, articulis duobus basalibus transversis, ultimo conico; prothorace oblongo-conico, sat fortiter convexo, subtiliter punctato; scutello manifeste transverso; elytris breviusculis, leviter striato-punctatis, interstitiis latis, planatis, impunctatis; tibiis fuscatis, integris. Long.  $1\frac{3}{4}$  lin.

*Hab.* Macassar.

Allied to *R. levigatus*, but the rostrum different, and the elytra impunctate, except in the striæ.

*Rhynchites æstuans.*

*R. fulvo-rufus*, lævissimus, nitidus, tibiis extus tarsisque nigrescentibus; capite impunctato; rostro prothorace vix longiore, fere obsolete punctato, basi integro; oculis haud prominulis; antennis mediocribus, articulis duobus basalibus majusculis, sequentibus gradatim brevioribus, clava magna, infusca, art. duobus basalibus transversis, ultimo conico; prothorace oblongo-conico, impunctato; scutello transverso; elytris breviter ovatis, seriatim ocellato-punctatis, interstitiis planatis, impunctatis; tibiis integris. Long.  $1\frac{3}{4}$  lin.

*Hab.* Tondano.

In outline closely resembling the preceding, but differing in coloration, sculpture of the rostrum, &c.

*Rhynchites leucothyreus.*

*R. subpurpureo-niger*, pube erecta grisea vestitus, scutello dense albivilloso; capite minusculo, angusto, inter oculos profunde longitudinaliter sulcato; rostro prothorace vix longiore, grosse punctato, a basi ad apicem gradatim latiore, longitudinaliter carinato; oculis magnis, prominulis; antennis articulo tertio, quarto quintoque conjunctim æqualibus, his sequentibusque gradatim crassioribus et plus minusve triangularibus; clava majuscula, articulis duobus basalibus oblongo-triangularibus, ultimo ovato-acuminato; prothorace oblongo, utrinque modice rotundato, confertim punctulato; scutello ovato; elytris breviusculis, profundè striato-punctatis, interstitiis convexis, in certa luce quasi subcostatis; tibiis subcompressis, integris. Long.  $1\frac{3}{4}$  lin.

*Hab.* Sula; Aru.

In contour like *R. conicus*, but with shorter elytra.

*Rhynchites venustus.*

*R. splendide aureo-cupreus*, subtus pedibusque concinne violaceis; capite elongato, angustato, inter oculos fovea profunde impresso; rostro capiti contiguo, modice elongato, compresso, lateribus basi planato, apice violaceo, dilatato; oculis modice prominulis; antennis articulis quinque basalibus subæqualibus, sexto obconico

septimo octavoque subtransversis; clava magna, articulis contiguis; prothorace ampliato, confertim punctulato, in medio canaliculato, lateribus antice in mare dente conico violaceo armato; scutello transverso, violaceo; elytris amplis, confertissime ruguloso-punctulatis; tibiis integris. Long. 3 lin.

*Hab.* Japan (Awomori).

This richly coloured species is closely allied to *R. betuleti*, but with a longer and more compressed rostrum, the prothorax more coarsely, and the elytra more closely and finely punctured, with the intervals rougher, &c.

*Rhynchites clavicornis.*

*R. cyaneo-chalybeatus*, parcius breviter griseo-pubescens; capite angusto; rostro prothorace vix longiore, a basi ad apicem sensim latiore, basi subquadrangulari, supra paulo excavato, lateraliter compresso; oculis haud prominulis; antennis breviusculis, articulis duobus basalibus longioribus et incrassatis, 6°, 7°, 8° transversis; clava magna, articulis contiguis, duobus basalibus late transversis; prothorace modice convexo, ampliato, confertim strigoso-punctulato, in medio linea longitudinali leviter impresso, in mare dente tenui antice armato; scutello valde transverso; elytris ampliatis, striato-punctatis, punctis oblongis, interstitiis ruguloso-punctulatis; tibiis integris. Long.  $1\frac{3}{4}$  lin.

*Hab.* Java.

This species may be placed between *R. rugosus*, Gebl., and *R. lacunipennis*, Jek. The club of the antennæ is nearly as long as the funicle.

*Rhynchites sculpturatus.*

*R. supra viridi-aureo-metallicus*, rostro, pedibus antennisque cyaneis; capite elongato, angusto, inter oculos fovea leviter impresso; rostro prothorace haud longiore, basi paulo compresso, versus apicem dilatato, cum capite sat grosse punctato; antennis art. quinque basalibus longitudine æqualibus, 6°, 7°, 8° gradatim brevioribus et erassioribus; clava sat magna, articulis contiguis; prothorace modice ampliato, confertim punctato, in medio linea longitudinali leviter impresso; scutello valde transverso; elytris ampliatis, sulcato-punctatis, punctis profundis subquadratis, plurimis oblongis, interstitiis rugoso-punctatis; tibiis integris. Long.  $2\frac{1}{2}$  lin.

*Hab.* India.

In some respects like *R. rugosus*, Gebl., but with the elytra regularly striato-punctate.

*Rhynchites cupido.*

*R. splendide cæruleus*, pilis paucis nigris erectis dispersis; capite magno, transverso, fere impunctato; rostro subvalido, perparum

arcuato, subpiceo, nitido, remote punctato; antennis nigris, brevibus, subbasalibus, art. duobus basalibus æqualibus, quam tertio quartoque paulo longioribus, quinto brevior, 6°, 7°, 8° rotundatis, moniliformibus; clava magna, distincta, art. duobus basalibus transversis, ultimo ovato; prothorace majusculo, subtransverso, utrinque rotundato, in medio anguste sulcato, remote punctulato; elytris fortiter sulcato-punctatis, punctis subquadratis approximatis, interstitiis uniseriatim leviter punctulatis; tibiis costulatis. Long. 2½ lin.

*Hab.* Penang.

In the size and form of its head this species approaches the genus *Auletes*.

*Rhynchites tenuirostris.*

*R. niger*, nitidus, parcius nigro-setulosus; capite antice modice lato; rostro tenui, fere recto, glabro, basi breviter tricarinulato; oculis valde prominulis; antennis longis, subbasalibus, articulis 7°, 8° longitudine 3°, 4° æqualibus; clava distincta, elongata; prothorace oblongo, subcylindrico, remote punctulato; elytris fortiter striato-punctatis, striis pilis albidis in serie unica remote obsitis, interstitiis modice convexis, remote uniseriatim punctulatis; tibiis longe pilosis costulatis. Long. 2½ lin.

*Hab.* Sarawak.

This and the preceding, although agreeing in the broad head, have radically different antennæ, and are in other respects very dissimilar.

*Rhynchites corallinus.*

*R. coccineus*, nitidus, apice rostri tibiisque infuscatis; capite pone oculos elongato, in medio transversim constricto, vage subtiliter punctulato; rostro prothorace sesquilongiore, basi culminato, apicem versus sensim fortiter dilatato; oculis prominulis; antennis nigris, articulis tertio quartoque longioribus et æqualibus, sequentibus sensim brevioribus et paulo latioribus, quinto sextoque minus triangularibus; tribus ultimis præcedenti vix crassioribus; prothorace vix longiore quam latiore, antice angustiore, utrinque rotundato, subvage punctato; scutello triangulari, sed fere invisio; elytris suboblongis, profunde sulcato-punctatis, interstitiis elevatis, confertim punctatis, griseo-pubescentibus; tibiis integris; tarsis articulo basali, præsertim posticis, elongato. Long. 3 lin.

*Hab.* Malacca.

This is an aberrant species, and when the sexes are known may probably be regarded as generically distinct.

XLIX.—*Descriptions of new Genera and Species of Lepidoptera in the Collection of the British Museum.* By ARTHUR GARDINER BUTLER, F.L.S., F.Z.S., &c.

Family Papilionidæ.

Genus SPHÆNOGONA, Butler.

1. *Sphænogona semiflava*, n. sp.

Primaries above sulphur-yellow, with a broad oblique brown external border, decreasing in width from the costa to the external angle, and very slightly sinuated along its inner margin; secondaries white, with a broad dentated brown border from the apex to the caudate projection; body greenish grey; collar with yellowish hairs; abdomen cream-coloured: wings below much as in *S. gratiosa*; primaries pale sulphur-yellow, gradually deepening in intensity towards the base, where they become saffron-yellow; secondaries cream-coloured, with the outer border pale sulphur-yellow; a few ill-defined brown lituræ in the usual positions: body cream-coloured.

Expanse of wings 1 inch 11 lines.

*Hab.* Trinidad (*H. W. Caird*). Type, B.M.

*S. semiflava* is most nearly allied to *S. ectriva*, but in colouring it approaches *S. gratiosa*.

Genus TERIAS, Swainson.

2. *Terias butyrosa*, n. sp.

Closely allied to *T. harina*, from which it differs in the considerably narrower black-brown border to the primaries.

Expanse of wings 2 inches.

*Hab.* Aru Islands (*Wallace*). Type, B.M.

We have two examples of this species and seven of *T. harina* in the collection.

3. *Terias solifera*, n. sp.

♂. Wings above bright golden yellow; primaries with a broad external dark brown border, nearly as in *T. sari* ♂; secondaries with costal and abdominal areas whitish; a rather broad, internally diffused and undulated dark brown border, tapering to apex and anal angle; fringe yellow; body greenish grey; wings below as in *T. senegalensis*.

Expanse of wings 1 inch 10 lines.

♀?. Sulphurous whitish, with the bisinuated excavation in

the outer border of primaries better marked and much less oblique.

Expanse of wings 1 inch 11 lines.

*Hab.* ♂, Ambriz; ♀, "Old Calabar, July 1872" (*Monteiro*). Type, B.M.

This species can easily be distinguished from *T. senegalensis* by the brighter and more sulphurous colour of the wings and the shape of the outer border of the primaries.

#### 4. *Terius diodina*, n. sp.

Wings above bright golden yellow; primaries with a rather broad deep-brown border, beginning upon the costa above the end of the discoidal cell, widening to apex and then narrowing to external angle, trisinate internally at its lower extremity, beginning from the third median branch; a trifurcate black spot at base; secondaries with the costal and internal areas whitish; a few brown scales along the outer margin; body greenish grey, abdomen cream-coloured; wings below golden yellow, primaries with the inner margin rather paler.

Expanse of wings 1 inch 9 lines.

*Hab.* Venezuela (*Dyson*). Type, B.M.

Allied to *T. flavilla*, but brighter in colour, with a narrower border to primaries and no brownish scales below.

### Family *Agaristidæ*.

#### Genus *MIMEUSEMIA*, n. gen.

Differs structurally from *Eusemia villicoides*, which it most resembles, as follows:—Wings considerably narrower; discocellulars of secondaries in a straight transverse line from subcostal to median nervure; antennæ shorter and more slender. Type *M. persimilis*, n. sp.

#### 5. *Mimeusemia persimilis*, n. sp.

Very like *Eusemia villicoides*, the primaries black, crossed by two or three plumbaginous lines; a spot near base of cell, a dot at centre of costal area, a large spot below it, cut by the median nervure and its first fork, and two large spots placed obliquely on apical area, yellowish cream-colour; secondaries deep orange, with a broad irregular costal and external black-brown border, a large black spot across the end of the cell, and a second touching the outer border upon the median interspaces; thorax black; crest, back of head, centre of collar,

pterygodes, and a spot on metathorax sulphur-yellow; abdomen orange, banded with black; antennæ black; primaries below with the internal area greyish with bronzy reflections; secondaries with the subcostal area of the ground-colour cream-coloured; otherwise as above: body below orange, varied with black.

Expanse of wings 2 inches 3 lines.

*Hab.* Hakodadi (*Whitely*). Type, B.M.

This is probably an imitation of *Eusemia*; its resemblance to *E. villicoides* can scarcely be accidental (in structure it more nearly agrees with *Alypia*). The *Hypercompa longipennis* of Walker is clearly an imitation of *Eusemia irenea*.

### Family Arctiidae (Zygænoïd type).

#### Genus ACRIDURA, n. gen.

In general appearance most like the Zygænoïd genus *Echoneura*. Wings narrow, hyaline, with veins black, margins opaque; primaries with four subcostal branches, the first emitted just before the end of the cell, the second and fourth from the end running close together at their origins, the third emitted from the second near its origin and running parallel to and above it; discocellulars transverse, the upper one reduced to a mere point; lower radial and second and third median branches emitted together at lower extremity of cell; secondaries with the cell short, its upper extremity projecting; subcostal with two branches, emitted from a footstalk beyond the end of cell, discocellulars forming a deep sinus, the upper considerably shorter than the lower; lower radial and median branches emitted together from the lower extremity of the cell; thorax broad; head small; palpi short; antennæ more or less filiform; abdomen slender, of the male with long compressed clasps. Type *A. gryllina*, n. sp.

#### 6. *Acridura gryllina*, n. sp.

♂. Wings hyaline white, with rosy reflections; veins, borders, and apex dark brown; base of costa steel-blue; an orange dot at the base; body orange, with the anal segments of abdomen and clasps steel-blue; head black; body below black, with purplish, steel-blue, and greenish reflections; base of abdomen with a white spot; tips of tarsi white.

Expanse of wings 1 inch 4 lines.

*Hab.* Espiritu Santo (*Higgins*). Type, B.M.

This remarkable species is, I believe, an aberrant Arctiid.



7. *Acridura metallica*, n. sp.

♀. General character of the preceding, but the body, with the exception of the back of the head and the front of the collar, metallic green; primaries with the veins, borders, and apex dark brown, the costal border to beyond end of cell metallic green; secondaries with the veins and borders black-brown; antennæ black, tipped with white; legs black, with purple reflections, tarsi of hind pair tipped with white.

Expanse of wings 1 inch 4 lines.

*Hab.* Espiritu Santo (*Higgins*). Type, B.M.

This species doubtless belongs to the same genus as the preceding; but the absence of the long anal clasps destroys the aberrant character of the type: I should, however, expect to find them, in the male, equally well developed with those of *A. gryllina*.

## Genus HYALEUCEREA, n. gen.

Nearly allied to *Eucereon*, but the wings hyaline, the costa of secondaries waved, the lower extremity of the discoidal cell projecting much more prominently forward, thus lengthening the lower discocellular, and the false recurrent vein not running to the base of the cell but to near the base of the median nervure. Type *H. erythrotelus*, Walker.

8. *Hyaleucerea vulnerata*, n. sp.

Head, palpi, collar, tegulæ, and thorax dark olive-brown; a spot on each side of the collar, two on the shoulders, one on the centre of tegulæ, and four on the thorax creamy white; abdomen slaty black, a dot at base and three subterminal transverse bands scarlet; wings hyaline, veins black; primaries with costal border alternately black and clay-coloured; a black litura across the middle of the cell and a large discocellular black spot, upon which the veins are marked in clay-colour; apical area broadly black, crossed obliquely by a squamose zigzag streak enclosing black spots; a white spot at apex; inner margin broadly clay-coloured, becoming black at base and external angle (where there is also a lunulate whitish dot), and crossed by two black lituræ; secondaries with a narrow irregular black border: body below greyish brown; base of palpi, coxæ, base of tarsi, and knees snow-white; abdomen with a decreasing series of four white spots on each side; wings with the opaque borders olive-brown, primaries with a white apical spot as above.

Expanse of wings 1 inch 7 lines.

*Hab.* Espiritu Santo (*Higgins*). Type, B.M.

## Genus THYSANOPRYMNA, n. gen.

Allied to *Eucereon*, but differing much in the neuration of the secondaries, and in the presence of a fringe of short hair-scales round the posterior margin of the last segment of the abdomen, and a tuft of hairs on each side of the anal appendices: the venation of secondaries is as follows:—subcostal with three branches, the first emitted before the end of the cell and running to costa, the second and third forming a fork to apex, one radial emitted from the end of cell, discocellulars forming a regularly arched sinus; median nervure with three branches, the third of which is forked beyond the end of the cell (this fork is probably produced by an aberrant position of the lower radial, from which the lower discocellular has receded). Type *T. pyrrhopyga* (Walker).

L.—*Descriptions of some undescribed Species of Birds discovered by Lieutenant Wardlaw Ramsay in Burma.* By ARTHUR, Viscount WALDEN, P.Z.S., F.R.S.

*Megalema Ramsayi*, n. sp.

The broad superciliary stripe composed of silvery-grey-centred feathers, giving a streaked appearance to the supercilium. Otherwise plumage and dimensions of *M. Franklini*.

I have compared a large series of typical examples of *M. Franklini* from Darjeeling and Asalu with a considerable series of this form obtained by Lieutenant Wardlaw Ramsay, at altitudes varying from 2000 to 4000 feet, in the Karen-hee hills. That gentleman records the iris as being "nut-brown; bill black, basal portion of maxilla and lower part of mandible slate-colour; legs dirty greenish white." Sexes alike.

*Æthopyga sanguinipectus*, n. sp.

Above as in *Æ. saturata* (Hodgs.), the yellow band on the rump being somewhat more developed. Underneath, all the chin, throat, and two streaks diverging from the throat and descending to the breast metallic violet-blue; upper part of breast velvety black; remainder of under surface pale yellow, many of the lower breast-feathers being centred and streaked with blood-red. A representative form of *Æ. saturata*.

Bill 0.65 inch, wing 2.12, middle pair of rectrices 3.25.

Described from six examples discovered and obtained by Lieutenant Wardlaw Ramsay on the Tonghoo hills (Karen-hee) at an elevation of 3000 feet.

*Dicæum olivaceum*, n. sp.

Above olive-green, the occipital feathers centred with pale brown, and those of the uropygium a few shades brighter green; rectrices black: below and lores cinereous, with a pale yellowish tinge, and the flanks with pale olive-green; quills brown, edged externally with olive-green of a rather brighter shade than that of the upper plumage.

Wing 1·75 inch, tail 1·7, tarsus 0·43, bill from forehead 0·38.

Described from four examples obtained by Lieutenant Wardlaw Ramsay on the Tonghoo and Karen hills. It only differs from *D. pygmaeum* (♀) by having the uropygium and upper tail-coverts brighter yellowish green, and the under tail-coverts a purer yellow; from *D. virescens* by wanting the albescent or pale grey throat and breast and the yellow abdomen.

*Ixus annectens*, n. sp.

Forehead, crown, and nape cinereous brown, each feather edged with golden olive-green, imparting an almost golden olive-green hue to those parts; interscapular region and back cinereous brown, tinged with olive-green, which colour is more intense on the rump; upper tail-coverts golden olive; primaries brown, edged with bright golden olive; major and minor coverts and secondaries dull olive-green; shoulder-edge, under shoulder-coverts, thigh-coverts, ventral region, and under tail-coverts bright yellow; chin and throat cinereous brown, most of the feathers with golden-yellow centres, imparting a streaked appearance, a few descending to the upper breast; flanks and remainder of lower surface cinereous brown; ear-coverts brown.

"Length 7·7 inches, tarsus 0·75, wing 3·3, tail 3·1, bill 0·85. Iris pale yellow; bill dark horny; legs leaden brown" (*Wardlaw Ramsay*).

Described from an individual obtained by Lieutenant Wardlaw Ramsay at Rangoon. His dimensions were taken from the fresh specimen. It is nearly allied to, though perfectly distinct from, *I. Finlaysonii*.

*Drymocataphus fulvus*, n. sp.

Above fulvous brown; feathers of head, nape, and back pale-shafted; lores, chin, throat, breast, thigh-coverts, sides of neck,

and under tail-coverts pale rusty fulvous; rectrices, outer edging of primaries and secondaries, and all the tertiary quills, pale liver-brown.

Wing 2·50 inches, tail 2·12, tarsus 1, bill from forehead 0·65; bill and legs, in dried skin, and claws pale fulvous. A typical form.

Karen-hee, at an elevation of 2500 feet (*Wardlaw Ramsay*).

*Trichastoma rubiginosa*, n. sp.

Underneath lively chestnut-red; mesial line from chin to breast, also of abdomen, white; above dingy olive-brown, somewhat tinged with ferruginous; remiges and rectrices pale brown, outer edges of quills ferruginous; inner edges of quills pallid rusty; lores grey.

Wing 3 inches, tarsus 1·38, tail 2·50, bill from forehead 0·94.

“Iris light brown to blackish brown; bill above pale (horny), below yellowish at gape; legs dull pinkish white. Karen-hee” (*Wardlaw Ramsay*).

Described from an example marked a female.

*Actinura Ramsayi*, n. sp.

Under surface from chin to vent clear ochreous buff, somewhat darker on the chin and throat; upper surface cinereous olive; forehead almost ferruginous; crown and crest, with the nape, like the back, but tinged with ferruginous; most of the dorsal feathers traversed by faint, yet distinct, narrow dark brown bands or lines, which on the upper tail-coverts are more closely set together and very conspicuous; lores and cheeks dark brown, almost black; sides of the head behind the eyes and some of the lateral crest-plumes ashy, without any ferruginous tinge; eyelids white; primaries narrowly barred with black on their outer webs up to their insertion, also the minor coverts; all the rectrices olive-brown, like the tertiaries, and distinctly barred with numerous well-defined narrow black bands; all but middle pair broadly tipped with white; under tail-coverts and flanks somewhat darker than remainder of under surface.

Wing 3·50 inches, tarsus 1·12, tail 5, bill from forehead 0·87.

“Iris light hair-brown, bill horny brown, legs slaty brown. ♀. Karen-hee” (*Wardlaw Ramsay*).

This is a representative form of *A. Egertoni*, from which it chiefly differs by its light ochreous under surface, by the

colouring of the upper plumage, by the primaries being barred throughout their length, by the minor coverts being barred, and by the distinct barring of the tail.

*Pomatorhinus Mariæ*, n. sp.

A stripe commencing at the nostril, and which passes back over the eye and down the sides of the neck, white, but partly rusty fulvous near the nostril; above this white stripe, and bordering its length, a narrow black stripe; all the head within the boundaries of the superciliary black stripe and the nape dark rusty olive; rest of upper surface dull olive-brown, with a rusty tinge; lores, cheeks, and ear-coverts black; chin and throat pure white; flanks, thigh-coverts, and under tail-coverts pale earthy brown, with a rusty tinge; breast and abdominal region pale creamy white or pale buff, contrasting with the pure white throat; quills and rectrices liver-brown.

Wing 3·50 inches, tail 4·25, tarsus 1·12, bill from forehead 1·18.

Described from an individual marked a female, and obtained in the Tonghoo hills by Lieutenant Wardlaw Ramsay. *P. Phayrei* is its nearest ally; but in it the entire under surface from the chin is bright ferruginous; it likewise has the entire upper surface of an almost uniform dull olive-brown, with but a faint ferruginous tinge.

LI.—*Descriptions of some new Genera and Species of Coleoptera from South Africa, Madagascar, Mauritius, and the Seychelle Islands.* By CHARLES O. WATERHOUSE.

MANY of the new genera described in this paper have been in the British-Museum collection for some years; but I have hitherto been unable to obtain names for them—and have been unwilling to describe them, on account of their position in a natural system being very doubtful. I have, however, now determined to make them known, with the view of obtaining the opinions of my entomological friends who are interested in classification.

GEODEPHAGA.

OZENINÆ.

*Pachyteles estriatus*, sp. nov.

*P. piceus*, nitidus; capite lævi, leviter convexo, fronte antice fovea leviter impressa; thorace capite paulo latiore, lævi, postice fortiter

angustato, marginibus reflexis; clytris capite thoraceque paulo longioribus, levibus; antennarum articulis quatuor basalibus nudis, rufescentibus. Long.  $5\frac{1}{2}$  lin., lat. 2 lin.

The general colour is pitchy; the base of the antennæ and the parts of the mouth are reddish, the apex of the mandibles black. The head is large, impunctate, with a slightly impressed fovea on the forehead. The thorax is a little broader than the head, one quarter broader than long, impunctate, truncate in front and behind, the anterior angles nearly right angles; the sides in front very slightly rounded, behind the middle very strongly sinuated, thus making the thorax much narrower behind than in front; the posterior angles are very slightly diverging, scarcely acute. The elytra are a little broader than the thorax at its broadest part, a little longer than the head and thorax taken together, gently convex, depressed on the back, impunctate and without striae. Anterior tibiæ somewhat strongly flexuous, the internal incision very strong, and tooth very acute. Antennæ as long as the thorax and head (without the mandibles), stout; the basal joint large, the second joint about half the size, the third and fourth a trifle longer, the fifth to tenth becoming a little broader and slightly transverse; the eleventh elongate, with the apex rounded.

*Hab.* Madagascar. B.M.

## LAMELLICORNIA.

### Hybosoridæ.

#### ARÆOTANYPUS, gen. nov.

Mentum quadrate, slightly rounded at the base, the anterior angles obliquely truncate; labium only slightly visible at the sides, on account of the angles of the mentum being truncate. Labial palpi very stout; the penultimate joint small, as long as broad; the apical joint large, ovate, scarcely truncate at the apex. Lobes of the maxillæ membranous, thickly clothed with stiff hair. Maxillary palpi with the apical joint four times as long as the preceding joint, subfusiform, with the apex very slightly truncate. Labrum transverse. Mandibles stout, much curved, with the apex acute; these with the labrum visible from above. Antennæ composed of eleven (?) joints; the first joint large, stout; the second nearly globular; the third nearly as long as the first, but comparatively slender, subcylindrical; the fourth, fifth, and sixth shorter, the sixth obliquely truncate at the apex; the seventh transverse, narrowed at its base; the eighth very short, and almost confluent with the first joint of the club; the ninth, tenth, and

eleventh joints forming a short ovate club; the ninth, the largest, shining, and slightly embracing the tenth and eleventh, which are spongy. Eyes large, not divided by a canthus. Thorax transverse. Scutellum triangular. Elytra elongate, slightly rounded at the sides. Abdomen composed of six segments; the basal one small and much hidden. Anterior coxæ rather large, conical. Metasternum short. Intermediate and posterior tibiæ furnished with two spurs at the apex, those to the intermediate pair being the longer; anterior tibiæ elongate, not much widened at the apex, with two strong teeth on the outer edge, and a smaller one nearer the base. Tarsi long and very slender, longer than the tibia, the anterior pair the longest, nearly twice as long as the tibia; the basal joint very short (club-shaped), not reaching beyond the apical tooth of the tibia; the second to fifth joints very long and slender, the fifth the longest. The claws very long, slender, very slightly curved, simple, about four fifths the length of the claw-joint.

I have placed a note of interrogation to the number of joints to the antennæ, as the eighth joint is somewhat doubtful; there is, however, an apparent suture between it and the first joint of the club, and I am not sure that I am correct in terming it a joint. I mention this, particularly as the structure of the antennæ inclines me to place the species in the vicinity of *Hapalonychus* (Hybosoridae), which should have only ten joints to the antennæ. Many of its characters, however, suggest an affinity with *Serica*; but I believe that it is rightly placed here.

*Aræotanypus boops*, sp. nov.

- A. piceo-niger, nitidus, fortiter punctatus; capite sat magno, planato, sat crebre punctato; oculis magnis rotundatis; thorace capite latiore, longitudine fere dimidio latiore, leviter convexo, antice paululo angustato, sat crebre fortiter punctato; scutello elongato-triangulari, fere lævi; elytris thorace paulo latioribus et  $2\frac{1}{2}$  longioribus, leviter convexis, irregulariter crebre fortiter punctatis, postice paulo ampliatis, ad apicem arcuatim attenuatis; pedibus longis; tibiis anticis extus tridentatis; tarsis testaceis, longissimis, gracilibus; unguibus gracilibus, simplicibus. Long.  $2\frac{1}{2}$  lin., lat.  $1\frac{1}{5}$  lin.

The clypeus is not separated from the forehead by any distinct line; it is transverse, and has the angles slightly rounded. The thorax has the anterior angles slightly prominent, scarcely acute; the sides are gently reflexed, very gently narrowed in front; the base is broadly lobed in the middle. The elytra are furnished with a stria near the suture. The underside of the body is very shining, not punctured. The three teeth on the outer edge of the anterior tibiæ are sharp, the basal one

very small. The femora and tibiæ are furnished with long delicate hairs. The tarsi are very slender, and have only one or two almost imperceptible hairs at the apex of the joints; the anterior pair are about four fifths of the length of the elytra, and are relatively longer than the posterior tarsi; the basal joint is very short. The antennæ are short; the club short, ovate, its basal joint shining.

*Hab.* South Africa, Lake Ngami. B.M.

### Melolonthidæ.

#### MACROPHYLLINÆ.

#### EUCYCLOPHYLLA, gen. nov.

Closely allied to *Macrophylla*, but differing in the following points:—Body short and broad. Clypeus completely rounded in front and at the sides. Antennæ ten-jointed; the first joint inflated; the second very transverse, broader than the first; third very short, triangularly produced on the inner side; fourth to tenth joints forming a large semicircular club. Anterior tibiæ bidentate.

#### *Eucyclophylla lata*, sp. nov.

*E. fusco-nigra*, subopaca, brevis, lata, leviter convexa; elytris picco-griseis; capite sat parvo, crebre fortiter punctato; antennis articulis quatuor basalibus piceis, alteris rufo-piceis opacis; thorace longitudine  $2\frac{1}{6}$  latiore, confertim subtiliter granuloso-punctulato, sat longe piloso, lateribus rotundatis, basi late lobata; scutello sat magno, sat crebre fortiter punctato; elytris thorace paulo latioribus et  $2\frac{3}{4}$  longioribus, apicem versus rotundatis, crebre fortiter punctatis, interstitiis confertim subtiliter punctulatis, dense breviter fusco-pubescentibus; corpore subtus pedibusque nitidis; pectore longe albo-piloso; tibiis posticis brevibus, ad apicem ampliatas. Long.  $7\frac{3}{4}$  lin., lat. 5 lin.

*Hab.* Cape of Good Hope. B.M.

#### *Cyclomera hirticollis*, sp. nov.

*C. elongata*, parallela, convexa, brunnea, flavo-pubescentis; fronte antice lamina transversa, brevi, nitida; clypeo concavo, discrete punctulato, marginibus fortiter reflexis, angulis anticis bene rotundatis; thorace longitudine  $\frac{2}{3}$  latiore, antice oblique angustato, longe flavo-pubescente, angulis anticis oblitteratis, lateribus antice reflexis, nitidis, basi in medio lobata; elytris thoracis latitudine et  $2\frac{1}{2}$  longioribus, leviter convexis, subtiliter punctulatis, fere parallelis breviter pubescentibus, singulis costis duabus; corpore subtus longe piloso; tibiis anticis fortiter tridentatis.

*Hab.* Lake Ngami. B.M.



This species differs somewhat from the typical *Cyclomera* in the form of the head, and in having the elytra less ample. The third, fourth, and fifth joints of the antennæ are transverse, the sixth with a short fine lamella, the seventh very small, the eighth, ninth, and tenth forming a moderate (slightly curved) club.

PARACLITOPA, gen. nov.

Very close to *Clitopa*, but differs in the following particulars:—Clypeus separated from the forehead by a strong line, completely rounded in front, with the margins reflexed. Forehead with a well-marked transverse arched keel. Antennæ ten-jointed; the first joint large, the second narrower and transverse; the third a little longer than broad, slightly narrowed at the base; the fourth shorter and with internal apical angle slightly produced; the fifth shorter and produced into a short lamella, the sixth and tenth forming a moderately long curved club. Elytra slightly narrowed towards the apex, and not covering the abdomen very perfectly. Anterior tibiae tridentate.

*Paraclitopa lanuginosa*, sp. nov.

♂. *P. fusco-grisea*, pubescens; capite picco-nigro, corpore subtus testaceo, antennis flavis; capite confertim punctato, clypeo margine reflexo; thorace longitudine duplo latiore, convexo, subtiliter confertim punctulato, longe testaceo-piloso, lateribus angulisque posticis rotundatis; clytris thorace paulo latioribus et  $2\frac{3}{4}$  longioribus, apicem versus paululo angustioribus, confertim asperato-punctulatis, breviter pubescentibus, singulis ad apicem rotundatis; pectore longe testaceo-piloso. Long. 6 lin., lat.  $2\frac{3}{4}$  lin.

*Hab.* South Africa, Lake Ngami. B.M.

PACHYPODINÆ.

ŒDANOMERUS, gen. nov.

Body thick, somewhat cylindrical, hairy. Clypeus and forehead each with a sharp transverse carina. Mentum small, diamond-shaped, truncate at the base. Labium and labial palpi not found. Maxilla short acuminate, with the apex slightly truncate. Maxillary palpi with the basal joint very small; second joint much larger and about three times as long as the first, truncate at the apex; the third joint slightly transverse; the apical joint as long as the two preceding taken together, inflated, fusiform, longitudinally impressed above. Mandibles triangular, simple. Antennæ rather short, eight-jointed; the basal joint slightly inflated, the second as long as broad, the

third, fourth, and fifth becoming shorter and broader, the sixth, seventh, and eighth forming an elongate-ovate thick club. Anterior tibiæ strong, with three teeth on the outer edge; the basal one small, the apical one very long, and reaching to the apex of the second joint of the tarsus. Tarsi as long as the tibia; posterior femora very large, ovate, flat on the inner side, convex on the outer side. Posterior tibiæ a little shorter than the femur, triangular, with a strong oblique setiferous carina; the apex furnished on the inside with two strong blade-like spurs, which are rounded at the apex. Intermediate tarsi long, about twice as long as the tibia; posterior tarsi a little longer than the tibia. All the claws simple. Abdomen short; the pygidium large, with the apex nearly reaching to the base of the femora.

I place this genus next to *Pachypus*.

*Ædanomerus hirsutus*, sp. nov.

*Æ. cylindricus*, albo-hirsutus, castaneus; capite thoraceque nigropiceis; capite, fronte clypeoque carina acuta transversa nitida instructis; thorace amplo, convexo, utrinque asperato-punctato, lateribus rotundatis (medio fere angulato), angulis posticis rotundatis; scutello lævi; elytris thoracis latitudinem æquantibus et hoc fere duplo longioribus, convexis, parallelis, ad apicem obtusis, sat crebre asperato-punctulatis, singulis costis duabus vix perspicuis. Long.  $3\frac{3}{4}$ – $4\frac{1}{2}$  lin., lat.  $1\frac{1}{2}$ –2 lin.

There is a fringe of stiff hairs between the two ridges on the head; the thorax is clothed with long whitish hair, the elytra with white scale-like hair, the underparts of the body with soft white hair.

*Hab.* South Africa, Lake Ngami. B.M.

TRICHINOPUS, gen. nov.

Mouth very small; mandibles very small, acute at the apex. Mentum very small; labium very elongate, narrow, parallel. Labial palpi with first and second joints small, quadrate; the apical joint rather longer than the two preceding taken together, ovate, with the apex scarcely truncate. Maxilla elongate, narrowed towards the base, truncate at the apex. Basal joint of the maxillary palpi very transverse, very small; second joint elongate, subcylindrical; third joint a trifle longer than broad, about half the length of the preceding; apical joint nearly as long as the two preceding joints taken together, subcylindrical, obtuse at the apex. Antennæ ten-jointed; the basal joint moderate, the second globular, the third about twice as long as the preceding joint, the fourth joint trans-

verse, the fifth to tenth forming an elongate club. Eyes rather large, somewhat approximate below. Thorax transverse. Elytra elongate, parallel, rounded at the apex. Anterior coxæ large, conical; anterior tibiæ short, wide at the apex, with two very strong teeth on the outer edge; tarsi nearly as long as the tibia; claws short, with a very strong tooth towards the apex. Intermediate tarsi long and slender, about one third longer than the tibia; the claws to these and the posterior tarsi very slightly curved, flexuous, with an obtuse tooth at the base, an acute tooth (made by a fissure) towards the apex; the apex very acute, curved. Posterior tarsi nearly  $3\frac{1}{2}$  times as long as the tibia, very slender; the basal joint the longest; all clothed with very long delicate hairs. Metasternum rather long. Pygidium acuminate.

I place this genus next to *Pachycolus*, but with some doubt.

*Trichinopus flavipennis*, sp. nov.

*T. elongatus*, parallelus, nitidus, hirsutus, pallide piceus, elytris flavo-testaceis; capite piceo-nigro, fronte discrete punctulata, planata; clypeo concavo, piceo, discrete punctulato, antice medio leviter emarginato, angulis rotundatis; thorace fere duplo latiore, longitudine  $\frac{1}{3}$  latiore, piceo, antice leviter emarginato, angulis anticis obtusis, lateribus rotundatis, angulis posticis omnino rotundatis, basi vix arcuata, disco utrinque discrete punctulato; scutello elongato-triangulari, piceo; elytris thorace vix latioribus, fere triplo longioribus, leviter convexis, flavo-testaceis, parallelis, ad apicem conjuncto-rotundatis, irregulariter sat crebre distincte punctatis; tibiis anticis brevibus, extus fortiter bidentatis, tarsis brevibus; tarsis intermediis longis; tarsis posticis longissimis, tibia fere  $3\frac{1}{2}$  longioribus, gracilibus, pilis pallidis prælongis ornatis. Long. 4 lin., lat.  $1\frac{1}{2}$  lin.

The whole upperside of this insect is clothed with pale pubescence, which is very long on the thorax and sides of the elytra. The underside of the body and the legs are moderately covered with long hair; the intermediate tarsi have only a few hairs at the apex of each joint; the posterior tarsi are remarkable for the very long pale delicate hair with which they are thickly clothed.

*Hab.* South Africa, Lake Ngami. B.M.

PERISSOSOMA, gen. nov.

Mentum broad at the base, acuminate in front; labium not distinct. Labial palpi with the two basal joints short; the apical joint elongate, fusiform. Mandibles short, triangular,  
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acute at the apex. Maxillæ short, the internal lobe terminating in a sharp point; the external lobe produced beyond the internal lobe, truncate at the apex. The palpi rather large; the basal joint small, elongate, bent in the middle; the second joint larger and about twice the length, truncate at the apex; the third joint rather shorter; the fourth rather longer than the two preceding joints taken together, fusiform with the apex slightly truncate. Antennæ with the first joint inflated, second joint a little longer than broad, the third, fourth, and fifth a little shorter, the sixth as long as the second joint; the seventh to tenth forming a long club, the seventh joint shining. Metasternum rather long; abdomen short; the pygidium large and triangular, the apex reaching in repose to the base of the femora. Anterior coxæ very large. Anterior tibiæ rather short, with two strong teeth on the outer edge; tarsi rather longer than the tibiæ; the inner claw bent at right angles near the base, which is furnished with a small tooth; the other claw, as well as the claws to all the other tarsi, quite simple, rather slender. Tarsi to the four posterior legs very long and slender, with strong bristles at the apex of the joints, the posterior pair nearly three times as long as the tibia.

I am not satisfied as to the position of this genus. It has somewhat the form of *Pachycolus*; and I therefore place it temporarily next to the genus *Trichinopus* above described.

*Perissosoma ænescens*, sp. nov.

*P.* oblongo-ovata, leviter convexa, ænescens, nitida; capite sat lato, fronte discrete subtiliter punctulata, antice impressa; clypeo transverso, antice leviter rotundato, crebre distincte punctato; thorace capite  $\frac{1}{3}$  latiore, longitudine  $\frac{2}{5}$  latiore, leviter convexo, discrete subtiliter punctulato, antice leviter emarginato, lateribus leviter rotundatis (medio fere angulatis) tenuiter marginatis, basi utrinque levissime sinuata; scutello triangulari, punctulato; elytris thorace paulo latioribus, medio paulo ampliatis, ad apicem obtusis, irregulariter striato-punctatis, interstitiis distincte discrete punctatis; sutura elevata, picea; corpore subtus piceo; pedibus longis, piceo-æneis, femoribus piceis. Long.  $4\frac{3}{4}$  lin., lat.  $2\frac{1}{4}$  lin.

The elytra are rather more distinctly punctured than the thorax, and the striæ are only traced near the suture and at the sides.

*Hab.* Seychelle Islands. B.M.

## SERRICORNIA.

## Buprestidæ.

*Ptosima magnifica*, sp. nov.

*P. elongata*, parallela, nitida, late ochracea, nigro-vel cæruleo-viridi ornata; clytris ad apicem truncatis serratis. Long.  $7\frac{1}{2}$  lin., lat.  $2\frac{1}{3}$  lin.

Form of *P. 11-maculata*, Hbst., but relatively longer, and with the thorax less ample, &c. Head bright orange-yellow, thickly and strongly punctured, with the neck, a spot on the crown, and two spots on the forehead blackish. Thorax one quarter broader than long, very slightly narrowed in front, gently convex, but flattened posteriorly, moderately and not very strongly punctured on the disk, closely and strongly punctured towards the sides; orange-yellow, with a broad sutural stripe and one on each side of it blackish. Scutellum æneous, shining. Elytra the same width as the thorax, and less than three times as long, attenuated towards the apex, strongly punctate-striate, the interstices with a row of punctures not placed very close together; orange-yellow, the suture, the apex, and a transverse band immediately before it, a longitudinal stripe from the shoulder reaching to the middle of each elytron, a spot on the suture behind the middle, and two spots on the margin bluish green. Apex of the elytra truncate, the sides towards the apex and the truncature serrated. Under-side of the body yellow, the various parts surrounded with bluish green. The mouth, antennæ, and legs green; the femora marked with yellow.

This species most nearly resembles *Pt. amabilis*, L. & G., but is at once distinguished by its larger size, by the thorax having three stripes, and by the apex of the elytra being serrated instead of having three strong teeth to each elytron.

*Hab.* South Africa, Limpopo. B.M.

## HETEROMERA.

## CELOMETOPINÆ.

## DYSCELADUS, gen. nov.

Mentum scarcely as broad as long, obtuse at the apex, very slightly emarginate. Apical joint of the labial palpi short, truncate at the apex; that of the maxillary palpi large, thick, almost securiform. Labrum projecting, slightly rounded in front, scarcely perceptibly notched in the middle. Head as in

*Celocnemis*, but narrower behind the eyes. Antennæ with third, fourth, and fifth joints subcylindrical, the third one third longer than the following, the sixth and seventh joints shorter and broader at the apex, the eighth, ninth, and tenth subquadrate; the eleventh oblong, rounded at the apex. Thorax large, transverse. Elytra short, very ample, convex, narrowed towards the base. Legs long and stout; femora subcylindrical, flattened below; tibiæ cylindrical, slightly flexuous, especially the anterior; the apical spurs hidden by the tomentum. Basal joint of the tarsi scarcely as long as the two following joints together; apical joint large. Intercostal projection of the abdomen very wide. Mesosternum very short, deeply triangularly emarginate. Metasternum very short. Body clothed with tomentum.

This very remarkable genus is evidently closely allied to *Celocnemis*, but is quite unlike in form and general appearance to any Heteromerous insect with which I am acquainted.

*Dysceladus tuberculatus*, sp. nov.

*D. niger*, opacus, dense fusco-griseo tomentosus; capite fere plano, antice truncato; thorace magno, antice posticeque angustato, longitudine  $\frac{2}{3}$  latiore, antice fortiter emarginato, angulis anticis sat acutis, lateribus rotundatis, angulis posticis acutis retrorsum directis, superne convexo tuberculis minutis aspero; scutello parvo; elytris thorace vix duplo longioribus, basi thorace angustioribus, postice rotundato-ampliatis ad apicem breviter attenuatis, convexis, ad suturam depressiusculis, tuberculis nitidis plurimis obsitis; pedibus longis, crassis. Long.  $14\frac{1}{2}$  lin., lat.  $7\frac{1}{2}$  lin.

The antennæ of this species are black, the five basal joints are shining and almost impunctate, the sixth and seventh are delicately punctured, the eighth to eleventh are granular with a smooth central line on the upperside. The sides of the thorax in the specimen described are slightly angular in the middle. I have seen the head and thorax of a second, larger specimen, in which the sides are evenly rounded.

*Hab.* Round Island, Mauritius. B.M.

RHYNCHOPHORA.

Anthribidæ.

*Tophoderes annulatus*, sp. nov.

*T. frenato* affinis; lineis parvis minus regularibus, tibiis nigris, albo annulatis. Long. 15 lin.

Closely allied to *T. frenatus*, and resembles it in form; it

is, however, less convex, and the thorax is broader in front. Black, with dark greyish pubescence. Rostrum clothed with whitish pubescence above; neck with three narrow white longitudinal lines, with a black spot behind the eyes. Thorax very broad and depressed, with three small tubercles on the disk, and with a strong triangular tooth on each side towards the front margin, as in *T. frenatus*; blackish, with fine whitish lines, those near the posterior margin forming an **M**. Elytra blackish, with some large tubercles placed as in *T. frenatus*, but more distinct; the whole surface covered with small whitish marks, not forming any bands as in *T. frenatus*. Legs black, a band on the femora, two rings on the tibiæ, the basal joint of the tarsi, and a ring on the claw-joint whitish. Abdomen in the male with a black velvety spot in the middle of the second, third, fourth, and fifth segments.

*Hab.* Madagascar. B.M.

## LONGICORNIA.

### Prionidæ.

#### *Closterus major*, sp. nov.

♀. *C. piceus*, capite thoraceque nigris; capite thoraceque crebre fortiter punctatis; scutello parce punctato; elytris obsolete 4-costatis, sat parce tenuiter punctatis; antennis corpore dimidio brevioribus, articulis 5<sup>o</sup>-10<sup>um</sup> brevipectinatis. Long. 21 lin.

Forehead deeply canaliculate; eyes separated above by a very narrow space. Antennæ with the third joint elongate, cylindrical; the fourth joint with a small obtuse tooth at the apex; the fifth to tenth joints becoming slightly shorter and broader, the internal apical angle of each joint produced into a tooth, more so as the joints approach the apex. Thorax convex, twice as broad as long, thickly and strongly punctured, sides with a short acute tooth in the middle—in these and other particulars agreeing with the thorax of *C. flabellicornis*. Elytra a little broader than the thorax, and five times as long, with four nearly obsolete abbreviated costæ; the surface somewhat sparingly and not strongly punctured.

*Hab.* Madagascar. B.M.

This species is at once separated from the *C. flabellicornis* by the sparse punctation of the elytra and by its much larger size.

## Cerambycidae.

## LEPTURINÆ.

*Sagridola quinquemaculata*, sp. nov.

*S. nigra*, elytris obscure fuscis; fronte, thorace lineis tribus, scutello, elytris maculis quatuor flavis. Long.  $6\frac{1}{2}$  lin.

Head black, with a broad longitudinal line in the middle and a narrow line on each side of it bright yellow; eyes prominent. Thorax scarcely longer than broad, slightly narrowed in front and constricted behind the middle, velvety black, with a broad sutural line and a broad stripe on each side bright yellow. Scutellum yellow. Elytra scarcely twice the length of the head and thorax taken together, broad at the base, much attenuated towards the apex, which is truncate, flat, the margins towards the apex slightly reflexed; shoulders at the sides somewhat thickly and strongly punctured; their colour is fuscous, with a large ovate spot in the middle of each, and the apex yellow. Antennæ slender. Legs and underside of the body pitchy black, with pale yellow markings on the epimera, parapleura, and the sides of the abdominal segment.

*Hab.* Madagascar. B.M.

LII.—*A List of the Gasteropoda collected in Japanese Seas by Commander H. C. St. John, R.N.* By EDGAR A. SMITH, F.Z.S., Zoological Department, British Museum.

ALL the specimens which represent the species included in the following list were liberally presented to the National Collection by Mr. J. Gwyn Jeffreys. Certain species dredged at the same time, and stated by Mr. Jeffreys (*Journal Linn. Soc., Zoology*, vol. xii. pp. 100–107) to be identical with, or but varieties of, European forms, will not now be enumerated, as they have not as yet come under my observation. Before commencing the list, I would add that the shells have been most admirably collected by Commander St. John, to whom the greatest praise and thanks are due. The care bestowed in preserving the exact localities, the depth at which they were dredged, at times even the temperature of the water, and also the nature of the sea-bottom, indicates a vast amount of labour and energy, which it would be well if more frequently imitated, as such information always greatly adds to the interest of the subject, and facilitates and adds security to the determination of species. In a future communication I propose to give a list of the Conchifera.



## GASTEROPODA.

1. *Terebra Adamsii*, Smith, Ann. & Mag. Nat. Hist. 1873, xi. p. 264.

*Hab.* Matoza Harbour, 6 fathoms, sand, long.  $136^{\circ} 55'$  E., lat.  $34^{\circ} 23'$  N.

2. *Terebra japonica*, Smith, *l. c.* p. 265.

*Hab.* Matoza Harbour, 6 fathoms, sand; and Goza Harbour, lat.  $34^{\circ} 18'$  N., long.  $136^{\circ} 45'$  E., 6 fathoms, sandy mud.

3. *Terebra evoluta*, Deshayes; Conchol. Icon. xii. f. 55.

*Hab.* Matoza Harbour, 6 fathoms, sand.

The figure above referred to represents an unusually large example, the average dimensions being but two thirds that size.

4. *Terebra albozonata*\*, sp. nov.

*Hab.* Matoza Harbour, 6 fathoms, sand.

This species is of a pale brown colour, with a narrow white zone above the suture, and also one around the periphery; it is furnished with numerous oblique ribs, which are cut across by a fine infrasutural furrow.

5. *Terebra melanacme*, sp. nov.

*Hab.* Cape Sima, 18 fathoms, sand and broken shells.

A smooth species, of a pale brown colour, with a white infrasutural zone dotted with chestnut, a plain white band round the periphery, and the apex stained with purplish black.

6. *Terebra (Myurella) bathyrhapse*, sp. nov.

*Hab.* Gulf of Yedo, 6 to 25 fathoms, bottom soft mud and sand.

This is a strongly sculptured species, with longitudinal ribs nodose at their extremities; the suture is well defined, and the general colour is a dusky brown.

7. *Terebra (Myurella) polygyrata*, Deshayes; Conchol. Icon. xii. sp. 146.

*Hab.* Goza Harbour, 6 fathoms, bottom sandy mud.

\* Full descriptions of the new species of Terebridae mentioned in this paper will be given elsewhere.

8. *Pleurotoma crispa*, Lamarek; Conchol. Icon. i. f. 11 a, b.

*Hab.* Ooshima Harbour, 8 fathoms, bottom sandy mud and shelly.

9. *Pleurotoma leucotropis*, Adams & Reeve, Voy. Samarang, p. 40, pl. x. f. 7.

*Hab.* Matoza Harbour, 6 fathoms, sand; and Ooshima Harbour, 8 fathoms, sandy mud and shelly.

10. *Pleurotoma vertebrata*, sp. nov.

Testa elongato-subfusiformis, alba, maculis fuscis variegata, versus apicem dilute violacea; anfract. 10, primi 3 convexi, vitrei, politi, sequentes 6 tricarinati (carina mediana maxima), inter carinas lira unica spirali, gracili, liris longitudinalibus numerosissimis concinne decussata (lira superiore ad locos intersectionis nodosa) ornati; anfr. ultimus inferne contractus, ad 14-carinatus (carina paululum peripheriam supra maxima); apertura parva, longitudinis testæ  $\frac{1}{3}$  vix superans, intus sulcata, sulcis costis externis respondentibus; labrum tenue, margine crenulatum; incisura lata, haud profunda, supra carinam maximam sita; columella leviter obliqua, medio obsolete uniplicata; cauda parva, alba; canalis perbrevis, latus, leviter recurvus.

Long. 16 mill., diam.  $5\frac{1}{2}$ .

*Hab.* Persian Gulf (*Colonel Pelly*); Matoza Harbour, 6 fathoms, sand (*St. John*).

The above name is applied to this lovely species because the fine nodose liration which encircles the whorls just above the large central keel is crossed by slender thread-like lines, diverging like the processes from a herring's backbone. The other fine lirations are regularly oblique. The prominent central keel and style of colouring at once distinguish this form.

11. *Pleurotoma* (—?\*) *Sancti-Ioannis*, sp. nov.

Testa fusiformis, sub epidermide fugaci olivacea pallide fuscescens; anfract. 10 convexiusculi, striis spiralibus tenuissimis subconfertis (in anfr. ultimo infra peripheriam majoribus) incrementique lineis flexuosis insculpti; apertura rufescenti-fusca, ovata, inferne contracta, canalem latum, breviusculum obliquum formans, circiter longitudinis totius  $\frac{2}{5}$  æquans; labrum tenue paululum supra medium late sinuatum; columella tortuosa, longitudinaliter scalpta; operculum unguiforme.

Long. 40 mill., diam. 14.

*Hab.* About 100 miles south-east of Yesso, 48 fathoms, sand and stones.

I feel much pleasure in dedicating this fine and very distinct

\* The subgenera of *Pleurotomidæ* will be given in a future paper.

species to Commander H. C. St. John, by whom it was discovered. The subconvex simple whorls, clothed with a smooth, thickish, olive epidermis, the wide sinuation of the lip, and the broad oblique canal are the principal characteristics.

12. *Pleurotoma (Drillia) flavidula*, Lamk. ; Con. Icon. i. *Pleurotoma*, f. 66 ; Kiener, Coq. Viv. *Pleurotoma*, pl. vi. f. 2.

*Hab.* North of Nippon, 43 fathoms, sand and mud ; west of Nippon, 3 fathoms, soft mud ; Goza Harbour, 6 fathoms, sand and mud.

13. *Drillia Jeffreysii*, sp. nov.

Testa fusiformis, subturrita, luteo-albida, purpureo-fusco maculata et punctata ; anfract. 13 superne concavi, inferne convexi, costis obliquis infra excavationem (in anfr. ultimo 14-15 ad peripheriam obsoletis) instructi, transversim ubique striati et graciliter lirati, liris 2-3 supra costas albidis, subnodosis, incrementique lineis flexuosis ornati ; apertura intus fuscescens, purpureo tineta, longitudinis testæ haud  $\frac{2}{3}$  æquans ; labrum medio extans, superne valde profundeque sinuatum ; canalis latus, brevis.

Long. 37 mill., diam. 11.

*Hab.* Goza Harbour, 3-43 fathoms.

The nearest allied species to the present one is *flavidula*, Lamarek, from which it differs in having a shorter aperture, a broader canal, and distinct spiral striation in the concavity which occupies nearly the upper half of the whorls.

14. *Pleurotoma (Drillia) chocolata*, sp. nov.

Testa fusiformis, nitens, saturate purpureo-fusca, zonis angustis tribus modo supra costas parentibus ornata ; anfr. 12, primi 2-3 convexi, læves, cæteri superne concavi, deinde convexiusculi, infra excavationem costis rotundatis paucis (in anfr. ultimo 9 ad peripheriam obsoletis) instructi, striis exilibus paucis spiralibus, sed haud in concavitate, inculpti ; anfr. ultimus infra peripheriam valde angustatus, ubique transversim striatus vel liratus ; apertura intus purpureo-fusca, longitudinis testæ ad  $\frac{2}{3}$  æquans ; labrum tenue, medio extans ; sinus mediocriter profundus ; canalis obliquus, recurvus.

Long. 21 mill., diam. 7.

*Hab.* Goza Harbour, 6 fathoms.

The dark chocolate colour, with the three yellowish spots (which are slightly nodulous) on each rib, and the smooth concavity at the upper part of the whorls are very distinctive characters.

15. *Pleurotoma* (—?) *inconstans*, sp. nov.

Testa oblonga, turrita, purpureo-fusca, circa anfractuum medium

nodulis flavicantibus ornata; anfract. 10-11 supra paululum excavati, medio angulati, superne ad suturam carina parva, pallida, subnodosa cincti, circa medium nodulorum flavicantium circiter 15 serie ornati, liris spiralibus ad 6 (inferioribus duabus infra nodulos sitis quam cæteris majoribus, tuberculisque parvis munitis) succincti; anfr. ultimus liris a nodulis descendentibus aliisque spiralibus concinne nodose clathratus; apertura fusca, intus lirata, longitudinis totius  $\frac{1}{3}$  paulo superans; canalis perbrevis, latus; sinus latus, supra nodulorum seriem situs.

Long. 13 mill., diam. 4.

*Hab.* Ooshima Harbour, 8 fathoms; Tsusima Strait, 9 fathoms; Matoza Harbour, 6 fathoms.

The lirations within the aperture are more distinct in some examples than in others.

16. *Pleurotoma* (—?) *tuberosa*, sp. nov.

Testa elongata, fusiformis, turrata, albida, apice fuscescens, strigis fuscis inter costas variegata; anfr. 12, primi duo vitrei, politii, globulares, cæteri convexiusculi, infra suturam undosam carinam leviter constricti et canaliculati, infra canalem costis crassis subobliquis (in anfr. superioribus nodulosis) (una hic illic quam cæteris majore tuberosa et fusca) instructi, spiraliter præcipue inter costas striati; anfr. ultimus circa peripheriam albo zonatus, costis ad 10 versus basim obsoletis, una post labrum maxima, fusca; apertura parva, alba, zonis duabus interruptis macularum externarum intus variegata, longitudinis totius  $\frac{1}{3}$  æquans; columella callo crassiusculo amicta, ad suturam tuberculata; canalis brevis, recurvus; labrum medio prominens superne valde sinuatum. Long. 22 mill., diam. 7.

*Hab.* Ooshima Harbour, 8 fathoms; Matoza Harbour, 6 fathoms; Goza Harbour, 6 fathoms.

This species possesses the general aspect of *varicosa*, Reeve; it is, however, distinct. The brown swellings or varices (in *varicosa* white), the brown apex, small aperture, and white band around the periphery easily separate this form.

17. *Pleurotoma* (—?) *erosa*, Schrenck:

*Pleurotoma* (*Clavatula*) *erosa*, Schrenck, Reisen u. Forsch. im Amurlande, pl. 17. f. 5-7.

*Hab.* Nemero, East Yesso, 3 to 4 fathoms; off Cape Blunt, 35 fathoms; Yamada Harbour, 7 fathoms; east of Niphon, lat. 34° 6' N., long. 136° 15' E., 11 fathoms.

Shell shortly fusiform, purplish brown, varying from half an inch to an inch in length. The whorls are angled at the middle, longitudinally plicated and transversely sulcated. The aperture is purplish brown, the notch of the labrum very slight, and the canal very short.

18. *Pleurotoma* (—?) *patruelis*, sp. nov.

Testa elongata, fusiformis, turrata, rubro-fusca, circa anfractuum medium albo zonata; anfr. ultimus paululum infra medium zona alba secunda ornatus; anfr.  $12\frac{1}{2}$  medio angulati, longitudinaliter flexuose obsolete plicati, plicis superne leviter nodulosis, medio nodulis majoribus et inferne nodulis duobus aliis minoribus munitis, filis spiralibus 10–12 tenuibus (iis nodulos conjungentibus quam cæteris crassioribus) succincti, et incrementi lineis striati; anfr. ultimus liris transversis circiter 24 succinctus; apertura longitudinis totius  $\frac{1}{3}$  adæquans; canalis brevis.

Long. 27 mill., diam.  $7\frac{1}{2}$ .

*Hab.* Lat.  $34^{\circ} 6' N.$ , long.  $136^{\circ} 15' E.$ , 11 fathoms.

This is a very pretty species, and belongs to the same group which includes *P. Metcalfei*, Angas, and some others.

19. *Bela iessoensis*, sp. nov.

Testa ovato-fusiformis, sordide albida; anfr. 6 convexi; primi 2 læves, cæteri plicis longitudinalibus subacutis (in anfr. ultimo 14 flexuosis, infra medium sensim evanescentibus) instructi, et striis confertis elevatis (una quam cæteris majore anfractuum medium succingente, in ultimo obsoleta) inter et supra costas ornati; apertura ovato-oblonga, subangusta, longitudine spiram æquans, intus fuscescens; columella lævis, alba, vix tortuosa; labrum tenue, superne leviter sinuatum; canalis brevissimus, latiusculus, aliquanto recurvus.

Long. 15 mill., diam.  $6\frac{2}{3}$ .

*Hab.* South-east of Yesso, lat.  $42^{\circ} 58' N.$ , long.  $104^{\circ} 24' E.$ , at a depth of 43 fathoms; bottom, sand and mud.

This very beautiful species is well characterized by its convex whorls, which are neatly plicated longitudinally—and especially by the close and fine spiral liration with which the entire surface is ornamented, one lira larger than the rest encircling the middle of each whorl.

20. *Murex* (*Chicoreus*) *adustus*, Lamk.; Conch. Icon. iii. f. 29; Kiener, Coq. Viv. pl. 33. f. 1.

*Murex despectus*, A. Ad. Proc. Zool. Soc. 1853, p. 72.

*Hab.* Ooshima.

Having carefully compared the type of *despectus* with specimens of Lamarck's species, I do not hesitate to place the former as a synonym; for I cannot trace any differences. Supposing the locality "West Indies," quoted by Mr. Adams, to be correct, then this is a remarkable instance of wide geographical range.

21. *Murex* (*Phyllonotus*) *acanthophorus*, A. Ad.  
Proc. Zool. Soc. 1862, p. 272.

*Hab.* Hakodadi, 5 fathoms.

The dimensions of this species, which are not given by the author, are, length 43 mill., diam. 25; aperture oval, purplish within, 11 mill. long,  $6\frac{1}{2}$  broad. Both the length and breadth of the shell will vary considerably according to the extent of the closed canal and the longitudinal varices; but the size of the aperture is more constant.

22. *Murex* (*Cerastoma*) *endermonis*, sp. nov.

Testa ovata, spira turrata, fuscescens; anfractus 6 superne decliviter tabulati, paululum supra medium angulati, infra angulum convexiusculi, varicibus 7 laciniatis superneque uncinatis instructi, liris spiralibus inæqualibus scabrosis cincti; regio umbilicalis valde perforata; apertura ovata, intus fusco-purpurea; labrum varice ultimo fimbriato incrassatum, intus denticulatum, margine serratum, versus basim dente magno prominenti munitum; columella cæruleo-alba, medio fusco-purpureo maculata; canalis clausus, breviuseculus, leviter recurvus.

Long. 33 mill., diam. 14.

*Hab.* Endermo Harbour, Yesso, 4 to 7 fathoms, sandy mud.

Some of the spiral lirations, that at the angle of the whorls and three or four others in the last whorl, are much larger than the rest, and with the varices produce a coarsely cancellated aspect. The base of the prominent tooth is purple-brown, and the point white.

*Murex taliénwhanensis*, Crosse, and *M. inornatus*, Récluz, are allies of this species; but both lack the labral tooth.

It is only in young specimens that the varices are produced upward in a somewhat hooked manner; in the adult state the extremities are generally worn off.

23. *Murex* (*Cerastoma*) *Burnettii*, Adams & Reeve, Voy. Samarang, p. 38, pl. viii. f. 4, a, b.

*Hab.* Endermo Harbour, Yesso, 4 to 7 fathoms; bottom sandy mud.

This species, which was founded upon a specimen in very bad condition now in the Museum collection, is allied to *C. foliatum*, Gmelin, from Sitka, Vancouver, and other localities on the west coast of North America.

The specimens dredged by Captain St. John at the above locality are in good condition.

The spiral ribs, which are not so prominent on the whorls as in *C. foliatum*, become very large towards the foliaceous varices, on which they are produced, thus giving them a very strongly digitated aspect. On two adjacent ribs of the whorls halfway between the varices there are distinct protuberances, which are not to be traced in Gmelin's species. The labral tooth is very strong and large, and excavated on the side towards the aperture, which is of a purplish red colour crossed by whitish stripes running down from the digitations which arm the edge of the labrum within the aperture. It is to be remarked that all the specimens of *C. foliatus* which I have examined have the labral tooth smaller and *convex* on the inner side, and not excavated as in *M. Burnettii*. The latter is of a pale fawn-colour varied with numerous whitish undulating streaks.

*C. coreanicum*, A. Adams, Proc. Zool. Soc. 1853, p. 72, is an allied species, but of smaller growth, about 2 inches in length; it possesses the same kind of labral tooth.

#### 24. *Trophon lamellosus*, Gray.

*Fusus lamellosus*, Gray, Zoology of Beechey's Voyage, p. 118, pl. 36. f. 13.

*Hab.* Lat. 42° 58' N., long. 145° 24' E., 48 fathoms, sand and stones.

#### 25. *Euthria viridula*, Dunker.

*Fusus viridulus*, Dkr. Moll. Japonica, p. 3, pl. 1. f. 16.

*Euthria viridula*, Dkr., Lischke, Japan. Meeres-Conch. p. 39, pl. 5. f. 5, 6.

*Hab.* Japan, lat. 41° 12' N., long. 140° 45' E., 43 fathoms.

In the specimens I have examined, the lirations within the aperture are only nine in number, whereas Dunker mentions the existence of twelve.

#### 26. *Euthria fuscolabiata*, sp. nov.

Testa fusiformis, saturate purpureo-fusca; anfractus 8-9, primi duo læves, cæteri convexi, plicis longitudinalibus circiter 12 (in anfr. ultimo prope medium obsoletis) instructi, sutura undulata sejuncti, transversim liris spiralibus tenuibus (quarum paucæ quam cæteris crassiores sunt) ubique cincti, et incrementi lineis distincte striati; apertura longitudinis totius  $\frac{1}{2}$  adæquans, superne ovata, infra in canalem obliquum, aliquanto elongatum et recurvum producta, intus albida, liris intrantibus ad 12 labri marginem haud attingentibus munita; labrum tenue, intus saturate fuscum; columella medio arcuata, basi obliqua, fusca, tenuiter callosa; cauda obsolete rimata; operculum elongate ovatum, nucleo apicali.

Long. 29 mill., diam.  $10\frac{1}{2}$ ; apertura long. 15, diam.  $5\frac{1}{2}$ .

*Hab.* Off Cape Blunt, lat. 41° 41' N., long. 141° 0' E., at a depth of 35 fathoms.

On the upper volutions four or five of the spiral lirations are considerably thicker than the rest, and on crossing the longitudinal plications are faintly nodulous. On all the five examples of this species there is what appears to be a luteous deposit; but this may be the vestige of an epidermis. The lines of growth are very distinct, and on crossing the spiral lirations make them somewhat scabrous.

27. *Fusus (Sipho?) manchuricus*, sp. nov.

*Fusus manchuricus*, A. Adams, MS.

Testa ovato-fusiformis, sub epidermide luteo-olivacea rufescens; anfractus 8 convexiusculi, plicis longitudinalibus arcuatis circiter 12 (in anfr. ultimo ad medium evanidis) instructi, ubique lineis impressis supra costas continuis, in anfr. superioribus 8-10, in ultimo 20-25 ornati; apertura superne aliquanto ovata, versus basim in canalem latiusculum, perobliquum et recurvum producta, intus rufescens, longitudinis totius  $\frac{1}{2}$  æquans; columella valde tortuosa, superne rufescens basique alba; labrum tenue; operculum ovatum, nucleo vix terminali.

Long. 27 mill., diam. 11; apertura long. 13 $\frac{1}{2}$ , diam. fere 5.

*Hab.* Lat. 42° 58' N., long. 145° 24' E., 48 fathoms, sand and mud.

This species is entirely clothed with a yellowish olive epidermis, beneath which the shell appears to be of a reddish colour. The plications or ribs are a trifle narrower than the interstices between them. The above name is attached to some specimens in the Cumingian collection; but I have been unable to find in what work Mr. Adams has given the description.

28. *Columbella tenuis*, Gaskoin.

*Hab.* Endermo Harbour, 4 to 7 fathoms, sandy mud.

The specimens which are associated with the above name have been compared with Gaskoin's type, which is in the collection of the late Mr. T. Lombe Taylor.

29. *Nassa marginulata*, Lamk.; Con. Icon. viii. f. 43; Kiener, Coq. Viv. pl. 29. f. 117.

*Hab.* Ooshima Harbour, 8 fathoms. Var. from Yamada Harbour.

30. *Nassa gemmulata*, Lamk.; Con. Icon. viii. f. 29; Kiener, Coq. Viv. pl. 22. f. 84 (*Buccinum*).

*Hab.* Gozo Harbour, 6 fathoms, sandy mud.



The operculum of this species has the outer edge, or that towards the labrum, prettily serrated. The Red Sea, Philippine Islands, New Guinea, and Queensland, Australia, are other localities of this species.

31. *Nassa stigmara*, A. Ad.; Conch. Icon. viii. f. 42.

*Hab.* Ooshima Harbour, 8 fathoms.

32. *Nassa spurca*, Gould, Otia Conch. p. 129.

*Hab.* Ooshima Harbour, 8 fathoms, and Yamada Harbour, 7 fathoms.

33. *Nassa balteata*?, Lischke, Japan. Meeres-Conch. p. 61, pl. v. f. 10, 11.

*Hab.* East Nippon, 11 fathoms.

A single specimen, which may be a variety of this species, differs in having a more acute spire, consisting of nine whorls, and below the suture numerous narrow oblique brown lines flowing from the brown spots which border the whorls.

34. *Nassa tenuis*, sp. nov.

Testa elongata, tenuis, lutescenti-alba, ad suturas et circa medium propeque basim anfr. ultimi pallide rubro fasciata; anfractus 8, primi duo læves, politi, cæteri convexiusculi, costis tenuibus 18-20 et liris spiralibus circiter 6 granulose clathrati, anfr. ultimus liris spiralibus 16-17 (inferioribus 5-6 circa caudam haud granulatis) cinctus; apertura parva, ovata, longitudinis totius  $\frac{1}{3}$  paulo superans; columella leviter corrugata callo tenui induta, superneque tuberculo parvo munita; canalis obliquus, brevis, recurvus; labrum incrassatum, intus denticulis circa 10 ornatum, medio basique rufo maculatum.

Long. 12 mill., diam. 5; apertura long.  $4\frac{1}{2}$ , diam.  $2\frac{1}{2}$ .

*Hab.* Cape Sima, 18 fathoms, sand and broken shells; Goza Harbour, lat.  $34^{\circ} 18' N.$ , long.  $136^{\circ} 45' E.$ , 6 fathoms, sandy mud; Ooshima Harbour, 8 fathoms, sandy mud and broken shells.

This is a very delicately sculptured species. The fine ribs and spiral lirations are very prettily and somewhat quadrately noduled at the points of intersection. One specimen is a little less elongate than the rest.

35. *Nassa fuscolineata*, sp. nov.

Testa brevis, pallide cornea, circa basim anfr. superiorum et medium anfr. ultimi linea fusca costis interrupta cincta; anfractus 8, primi tres læves, politi, cæteri convexiusculi, costis rotundatis 12

(in anfr. ultimo basi fere continuis) instructi, sulcis angustis circiter 6 (in ultimo ad 15) supra costas continuis inculpti, sutura undulata discreti; apertura parva, rotunde ovata; labrum incrassatum, medio basique fusco maculatum, intus liratum; canalis angustus, brevis, leviter recurvus; columella arcuata, lævis, callo tenui induta.

Long.  $8\frac{1}{2}$  mill., diam.  $4\frac{1}{2}$ .

*Hab.* Cape Sima, 18 fathoms, bottom sand and broken shells.

Above the spiral interrupted brown line a white one adjacent to it is discernible; and on the body-whorl somewhat below the middle there are two other, very pale brownish lines interrupted by the ribs, which are a little broader than the interspaces.

36. *Purpura lapillus*, Linn.; Conch. Icon. iii. f. 47, *a*, *b*.

*Hab.* Japan.

The Japanese forms of this Protean shell are as varied as those on European shores. In some specimens the imbrications are prominent, as in Reeve's figure 47 *b*, but much more numerous, in some cases groups of six or eight being quite contiguous. In other examples the imbrications are nearly obsolete.

37. *Purpura alveolata*, Rve. Conch. Icon. iii. f. 60.

*Hab.* Ooshima.

Reeve gives "Panama, *Cuming*," as the locality of this species. It does not appear in Mr. A. Adams's list of Japanese *Purpurina*, given in the 'Annals,' 1870, vol. v. p. 422; and therefore probably it has not been recorded from so northern a locality. There are in the Museum collection other specimens from Formosa and Swan River.

38. *Sistrum tuberculatum*, Blainv.; Conch. Icon. iii. *Ricinula*, f. 11; Kiener, Coq. Viv. *Purpura*, pl. 5. f. 10, 10 *a*.

*Hab.* Toba and Ooshima, on the shore.

39. *Buccinum Jeffreysii*, sp. nov.

Testa ovato-fusiformis, alba, carinis rufo punctatis ornata, epidermide sordide olivaceo-alba longitudinaliter lamellosa amicta; anfractus  $6\frac{1}{2}$ , primi duo læves, rufescentes, globulares, cæteri convexi, liris vel carinis tenuibus 6-7 (in anfr. ultimo circa 20-24), una leviter undulata circa medium quam cæteris majore, cincti,

ubique lineis longitudinalibus tenuissimis elevatis confertis inter liras pulcherrime ornati; apertura alba, ovata, basi late breviterque canaliculata, longit. totius  $\frac{7}{5}$  adæquans; canalis recurvus; columella lævis, tenuiter callosa, alba; labrum incrassatum, aliquanto reflexum; operculum certe buccinoidale.

Long. 30 mill., diam.  $14\frac{1}{2}$ ; apertura long. 14 mill., diam.  $6\frac{1}{2}$ .

*Hab.* Lat.  $42^{\circ} 58'$  N., long.  $145^{\circ} 24'$  E., 48 fathoms, sand and stones.

This species may eventually prove but a large and fine variety of *B. japonica*, A. Adams; but at present I distinguish it with a separate name, since there are several differences which may be regarded as specific. The whorls are only slightly angulated in the middle by the keel which encircles them at that part; and this keel is undulated, a character not assigned to *B. japonica*; the red spotting on the keels is also absent in that species; and the colour of the epidermis is different. At the base of the cauda in the present species there is a largish excavation; but I am inclined to attribute it to a repaired injury.

#### 40. *Volutharpa ampullacea*, Middendorff.

*Bulla ampullacea*, Midd. Sibirische Reise, Theil ii. pl. 8. f. 3 & 4.

*Hab.* Lat.  $41^{\circ} 12'$  N., long.  $140^{\circ} 45'$  E., at a depth of 43 fathoms, bottom sand and mud.

#### 41. *Mitra (Costellaria) suluensis*, Ad. & Rve.

*Mitra suluensis*, Ad. & Rve. Voy. Samarang, pl. 10. f. 27.

*Hab.* Ooshima Harbour, 8 fathoms, sandy mud and broken shells.

#### 42. *Mitra (Costellaria) Collinsoni*, A. Ad. Journ. Linnean Soc. 1864, vii. p. 200.

*Hab.* Ooshima Harbour, 8 fathoms; Matoza Harbour, 6 fathoms.

The dimensions of this species are, length 18 mill., diam. 6. I give these measurements, as they are omitted by Mr. A. Adams, whose practice it nearly always is to pass them over as of no importance.

#### 43. *Cancellaria Spengleriana*, Desh.; Conch. Icon. x. f. 11; Kiener, Coq. Viv. pl. iv. f. 1.

*Hab.* Japan, lat.  $35^{\circ} 7'$  N., long.  $136^{\circ} 55'$  E., 3 fathoms; soft mud.

*Ann. & Mag. N. Hist.* Ser. 4. Vol. xv. 30

44. *Admete ovata*, sp. nov.

Testa ovata, tenuis, semipellucida caruleo-alba; anfractus 4-5 convexi, supremi 2-3 erosi, penultimus longitudinaliter oblique plicatus, plicis superne suturam non attingentibus et spiraliter striatus, ultimus maximus, subglobosus, striis spiralibus circiter 20 insculptus; apertura ovata, longitudinis totius  $\frac{8}{11}$  adæquans; columella arcuata, callo tenuissimo induta, basi oblique truncata.

Long.  $6\frac{1}{2}$  mill., diam.  $3\frac{1}{2}$ ; apertura long. 4 mill., diam. 2.

*Hab.* Lat.  $42^{\circ} 52'$  N., long.  $144^{\circ} 40'$  E., 48 fathoms, sand and mud; temperature at bottom  $37^{\circ}$ - $39^{\circ}$ .

This species is peculiar for its ovate form and very short spire. Only the penultimate whorl appears to be plicated.

45. *Admete globularis*, sp. nov.

Testa parva globularis, tenuis, nivea; anfractus  $4\frac{1}{2}$ , primi tres parvi convexiusculi sutura leviter canaliculata sejuncti, ultimus globosus magnus, omnes spiraliter tenuissime sulcati, apertura aliquanto magna, subpyriformis, longitudinis totius fere  $\frac{3}{4}$  æquans; columella callo tenui lato supra anfractum producto amicta, versus basim oblique truncata; labrum tenue, simplex.

Long. 4 mill., diam. anfract. ultimi 2.

*Hab.* Lat.  $42^{\circ} 52'$  N., long.  $144^{\circ} 40'$  E., at a depth of 48 fathoms, on a sandy bottom, with a temperature of  $37^{\circ}$ - $39^{\circ}$ .

This is a very remarkable species, and unlike any shell which has ever come to my notice, and probably may eventually be placed in a distinct genus. It is in form very much like *Cassia saburon*; and the truncature of the columella resembles that of *Verena crenocarina* in the Melaniadæ, or of the genus *Achatina* among the Pulmonata. The thin callous deposit extends from the juncture of the labrum with the body-whorl to the end of the columellar truncation, and spreads out some distance over the whorl.

46. *Oliva (Porphyria) mustelina*, Lamk.; Conch. Icon. vi. f. 23.

*Hab.* East of Nippon, 3 fathoms, soft mud.

47. *Olivella fulgurata*, Adams & Reeve.

*Oliva fulgurata*, Adams & Reeve, Voy. Samarang, pl. x. f. 12.

*Oliva Fortunei*, A. Adams, MS. in Coll. Cuming.

*Hab.* Yamada Harbour, lat.  $39^{\circ} 32'$  N., long.  $141^{\circ} 53'$  E., in 7 fathoms, bottom sand and broken shells.

The Japanese specimens are of a pale horny colour, variegated with undulating chestnut markings.

48. *Natica janthostoma*, Deshayes, Mag. de Zool. 1841, pl. 45 ;  
Conch. Icon. ix. f. 79a, b.

*Hab.* Nembro, East Yesso.

Three young specimens are rather differently coloured from the typical form. The chief colour of the body-whorl is a pale yellow, which is interrupted by two broad brown spiral bands.

49. *Natica Colliei*, Récluz ; Reeve, Conch. Icon. ix. f. 112a, b.

*Natica concinna*, Dunker, Malak. Bl. 1860, p. 232 ; Moll. Japonica, p. 14, pl. ii. f. 21.

*Hab.* Matoza Harbour, 6 fathoms, sand.

*N. concinna*, Dunker, is undoubtedly the same as *N. Colliei*, Récluz, his description agreeing in every particular with the latter species.

The operculum is calcareous, and externally deeply and spirally sulcated, as in *N. millepunctata*, Lamk.

50. *Obeliscus pulchellus*, A. Ad. Thes. Conch. ii. p. 808,  
pl. 171. f. 20.

*Hab.* Goza Harbour, 6 fathoms, sandy mud.

51. *Syrnola cinctella*, A. Ad. Ann. & Mag. Nat. Hist.  
1860, vi. p. 333.

*Hab.* Matoza Harbour, 6 fathoms, sand.

52. *Solidula strigosa*, Gould, Otia Conchol. p. 114, as  
*Buccinulus*.

*Hab.* Gozo Harbour, 6 fathoms, sandy mud.

[To be continued.]

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LIII.—*Notes on Carboniferous Lamellibranchiata.*

By R. ETHERIDGE, jun., F.G.S.

[Plate XX.]

Genus MYALINA, De Koninck,

Descr. Animaux Foss. Terr. Carb. Belgique, p. 125.

(Redefined by M'Coy, Brit. Pal. Foss. p. 491.)

*Myalina crassa*, Fleming.

*Modiolus*, sp., Fleming, Edinb. Phil. Journ. 1825, xii. p. 246 (without description).

*Mytilus crassus*, Fleming, British Animals, 1828, p. 412.

? *Modiola*, sp., Rhind, Age of the Earth, 1838, p. 167, t. 2. f. *g* (without description).

*Mytilus* (*Myalina*) *crassa*, King, Mon. Perm. Foss. Engl. 1850, p. 159 (without description).

*Mytilus crassus*, Morris, Cat. Brit. Foss. 1854, p. 214 (without description).

*Myalina crassa*, Huxley & Etheridge, Cat. Foss. Mus. Pract. Geol. 1865, p. 110 (without description).

*Myalina crassa*, Armstrong & Young, Cat. Carb. Foss. W. Scotland, Trans. Geol. Soc. Glasgow, 1871, iii. Supp. p. 52 (without description).

*Spec. char.* Shell elongate, obliquely subtrigonal, very thick, with strongly marked umbonal ridges, inequivalve, large when full-grown. Anterior end forming a small lobe in front of the beaks and umbonal ridges; its margin sinuous, and a little concave in outline. Posterior end compressed in comparison with the anterior; its margin slightly sigmoidal in outline. Hinge-line straight, nearly equal to the length of the shell. Beaks not quite terminal, small and pointed, a little incurved at their apices. Umbonal ridges prominent, extending from the beaks backwards and downwards to opposite the anterior part of the ventral margin, where they become lost in the general surface of the shell; they are most prominent immediately below the umbonal region, and give to the valves a carinate appearance. Hinge-plate broad, with the inner margin a little thickened, and longitudinally marked by a very large number of cartilage-furrows. Byssal sinus in the right valve more developed in some individuals than in others. Anterior adductor impression double, pit-like, and deep, placed within the umbonal cavity. Posterior adductor impression large and transversely elongated. Pallial line well marked in old individuals by a series of pits along its course; remote from the margin of the valves. Shell-substance very thick, especially in the umbonal region and cardinal area. Surface covered with an epidermal investment, ornamented by close fine striæ.

*Obs.* *M. crassa* was in the first instance referred to by the late Rev. Prof. Fleming as a *Modiola* in his paper on the Testaceous Annelides, as quoted above, but was afterwards briefly described by him as a fossil species of the genus *Mytilus*. With this short description, and a figure of a *Modiola* in Rhind's 'Age of the Earth,' from the water of Leith, near Woodhall (where it occurs in some abundance), which I believe to be the same shell, the early history of *M. crassa* is completed, so far as the literature of the subject is known to me. The greatest number of cartilage-furrows I have counted on the hinge-plate of any one specimen is twenty-four. These grooves are apparently continuous round

on the sinuous margin of the anterior side, where, however, they are only the edges of the laminae composing the shell—a fact extremely well shown in one of the typical specimens (No. 219) in the “Fleming Collection,” Edinburgh Museum of Science and Art, for access to which I am indebted to the kindness of my friend Dr. Traquair. In the right valve of some specimens the hinge-plate appears to be thicker and more highly developed than in the left. In old specimens the pallial line becomes exceedingly well marked, a series of pits indicating the points of attachment of the mantle-fibres. In the larger number of specimens of *M. crassa*, the posterior sides of the shell are usually broken away, indicating that they were thinner and more delicate than the anterior. At certain localities the thickness of the valves of this species is remarkable, so much so as to leave, in some instances, little room for the mollusk. The scar of the anterior adductor is placed well within the umbonal cavity, and in both valves is either single and pit-like, or may consist of two deep pits separated by a ridge, and often bounded posteriorly by a raised rim or margin. Over each, and a little posterior to the single or double impressions, is a third and smaller pit, which was ascertained by Prof. McCoy\*, as stated in his emended description of the genus *Myalina*, to be the scar of the insertion of the adductor of the opposite valve, similar to those *Mytili* with rostral plates, and not that of one of the pedal muscles, the larger impression in each valve being therefore only the origin of the respective adductors. Immediately in front, and within the angle formed by the hinge-plate and the anterior margin, is another, shallower depression, from which a depressed and more or less interrupted line runs in many specimens across the cartilage-area, sometimes even interrupting the furrows themselves. These points are well shown in figs. 1 & 2 (representing the interior of portions of a right and a left valve), where *b* is the double origin of the anterior adductor, *c* the insertion of the adductor of the opposite valve, *d* the shallower impression from which runs the groove *e* across the cartilage-furrows. The late Prof. Pictet noticed the resemblance of the rostral septum characteristic of the genus *Myalina* to the shelf of the living *Dreissena*, on which is supported the anterior adductor; it may be that the elevated rim or margin, which I have described above as bounding the anterior scars of *M. crassa*, may still further tend to unite the two genera. From the condition of the specimens, I have been unable to study the

\* Brit. Pal. Foss. p. 492.

posterior adductor-scars with satisfaction. Fig. 3 represents the posterior portion of a shell with a strong muscular scar, which, I think, may be that of *M. crassa*; it was obtained at Pitlessie with many fragments of that species, and from the same block of shale. The margin of the scar is strongly defined; and there are several pits scattered along it and over the surface of the impression, probably marking the points of attachment of muscular fibres.

In the water of Leith at Woodhall a bed of dark shale occurs, with a species of *Myalina* in abundance, the individuals varying in size from small specimens up to near that of the typical *M. crassa*. Except that the shell of the Woodhall form is thinner, and, as before stated, smaller, I cannot distinguish one from the other.

*Localities &c.* Cults Lime-works, near Pitlessie, Fife, "in a bed of shale over the Mountain Limestone;" Fleming Collection, Edinburgh Museum of Science and Art, and collection of the Geological Survey of Scotland: collected by Messrs. Bennie and Macconochie. Lugton Water, near Lugton Inn, near Dunlop, Ayrshire, in shale in connexion with the lowest limestone of the Lower Carboniferous Limestone group; collection of the Geological Survey of Scotland, collected by Mr. A. Macconochie. Woodhall, water of Leith, in shale of the Wardie Shale series, Lower Carboniferous series; cabinet of Dr. Traquair, and collection of the Geological Survey of Scotland: collected by Mr. J. Bennie. Messrs. Armstrong and Young record *M. crassa* from shale below the main limestone at Roughwood, and from clay-ironstone shale at Corrieburn\*.

In the article on "Fife and Kinross," in the 'New Statistical Account of Scotland'†, is the following reference to the bed of shale at Cults Lime-works:—"One of the beds of shale which overlies the main lime is composed entirely of shells of the genus *Mytilus*, the prevailing species being the *M. crassus*. These shells appear as fresh and entire as if they were still reposing on the mud bed of the primitive ocean in which they were produced. Not only are the external figure and internal structure preserved, but even the colour and original shelly matter seems to have sustained but little alteration."

Many of the valves of *M. crassa* from Cults have attached to them a large *Spirorbis*, described by Fleming in his memoir on the Testaceous Annelides as *S. ambiguus*. Mr. Bennie has met with a similar form at Roscobie, Fife.

\* Trans. Geol. Soc. Glasgow, iii. Supp. p. 52.

† Vol. v. p. 559.



Genus SCHIZODUS, King, 1844,

Annals Nat. Hist. 1844, xiv. p. 313; Permian Fossils, 1850, p. 185.

*Schizodus Salteri*, sp. nov.

*Schizodus*, sp. (Salter), Rev. T. Brown, Trans. Roy. Soc. Edinb. 1861, xxii. p. 392, figs. 1-3.

*Spec. char.* Very inequilateral, convex and prominent in the umbonal region; anterior side rounded; posterior side longer and more compressed than the anterior, slightly truncated obliquely, narrowed by the convergence of the dorsal and ventral margins; ventral margin gently rounded; an obtusely rounded and curved diagonal ridge proceeds from the beak of each valve to the postero-ventral margin, enclosing between it and the dorsal margin a narrow, slightly concave, posterior slope. Beaks pronounced, prominent, slightly incurved towards the anterior side; valves very prominent and convex in the umbonal region, rapidly arching downwards to the rounded ventral margin. In the right valve the anterior tooth is inclined a little obliquely towards the anterior side; the posterior tooth is elongated. In the left valve the large central tooth is very prominent, thick, plain, and projects somewhat outwards from the umbonal cavity; although not bifid, the ventral margin of this tooth appears in some specimens to be very slightly concave, thereby indicating a tendency towards the bifid form; anterior and posterior teeth obscure. The scar of the anterior adductor is oval, and attenuated towards its dorsal extremity; the posterior impression also oval, but rather larger than the anterior. Pallial line well defined on the anterior and posterior sides, less so in the middle of its course; an internal curved ridge extends from the umbonal cavity on the posterior side obliquely towards the postero-ventral margin, and nearly corresponds in position with the diagonal ridge. Surface of the shell towards the ventral margin is marked by several well-defined laminae of growth, between which and over the general surface are close fine striae, usually only faintly preserved.

*Obs.* In connexion with this shell, the Rev. T. Brown makes the following remarks in his paper on the "Mountain Limestone and Lower Carboniferous Rocks of the Fifeshire Coast, &c."\* :—"Dr. Fleming, to whom I formerly submitted this shell, considered it to be the *Anatina attenuata* of M'Coy, but held that it had been erroneously referred to that genus. He possessed numerous specimens from a bed near Colinton, where it occurs in such abundance as to suggest the idea of its

\* Trans. Roy. Soc. Edinb. xxii. p. 393.

having been gregarious; but the specimens from Fife were in better preservation, and he intended to have them laid open and submit them to a careful examination in order to determine the generic characters. Circumstances prevented this, but it has now been made clear by Mr. Salter." Many years ago Dr. Rhind figured, but did not describe, under the name of *Axinus Pentlandicus*\*, two shells from Woodhall (probably the Colinton of the above quotation), which I believe to be specifically distinct from one another. One of these† was afterwards refigured and described by Capt. T. Brown as *Pachyodon pyramidatus*‡, without any reference to Rhind's figure, and again as *Unio pyramidalus*§. I am at present under the impression that Rhind's fig. *b* and Brown's *P. (Unio) pyramidalus* are the same shell as the present species, which I have ventured to describe under the name of *S. Salteri*, in memory of an early preceptor and friend to whom I am indebted for many pleasant rambles and much profitable instruction. The posterior slope of *S. Salteri* is very frequently broken or crushed away, when the individuals bear a close resemblance indeed to the above shells, in which there is no slope figured, the posterior side consisting of a blunt acumination. If future investigation should prove them to be identical, Capt. Brown's specific name will have to be adopted. The Rev. Thomas Brown has most obligingly allowed me to examine the original specimens in his cabinet used by Mr. Salter for the woodcuts cited above. Of these, fig. 1 represents the internal umbonal region of the right valve, and shows the anterior tooth of the natural size. In fig. 2 we have a view of the whole of the interior of the left valve, with an enlarged drawing of a portion of the hinge, and showing the plain surface and wedge-form of the tooth, which in some *Schizodontes* is bifid. The third figure is a good external representation of the left valve, with the general characters well indicated, except that the laminae of growth on the upper half of the shell are too pronounced. It is an enlarged figure, although the species frequently reaches the size indicated. In the thick undivided nature of the central tooth of the left valve, *S. Salteri* quite agrees with two other Carboniferous species in which the dental arrangement has been noticed—*S. carbonarius*, Sow., and *S. axini-formis*, Phil.; in both of these the corresponding tooth is simple and thick, thus presenting a marked difference from

\* Age of the Earth, t. 2. f. *a* & *b*.

† Fig. *b*.

‡ Annals Nat. Hist. 1843, xii. p. 396, t. 16\*. f. 9.

§ Fossil Conchology, p. 179, t. 73. f. 19.

| King, Mon. Perm. Foss. p. 187.

the bifid tooth of the Permian form, *S. truncatus*, King. Perhaps when more is known of the dental characters of the various species constituting the genus *Schizodus*, we may be able to separate them into two natural groups based on the divided or undivided condition of the large central tooth of the left valve.

*Localities &c.* Ardross Limestone, Ardross, Fifeshire, at the base of the Lower Carboniferous Limestone group; cabinet of the Rev. T. Brown, who remarks that it is one of the characteristic shells of that bed. Cambo Ness, Kingsbarns, Fifeshire, from the *Myalina*-beds of the Lower Carboniferous series (Cement-stone group); collection of the Geological Survey of Scotland. Water of Leith, at Woodhall, in shale under a bed of sandstone of the Wardie Shale group, Lower Carboniferous series; cabinet of Dr. Traquair, and collection of the Geological Survey of Scotland (specimens collected by Mr. J. Bennie).

The Rev. T. Brown remarks that "the species seems to have belonged properly to the Lower Carboniferous group, rather than to the Mountain Limestone. . . . On passing up into the Mountain Limestone it occurs rather in a straggling condition, and in comparatively scanty numbers."

In conclusion, I have to express my thanks to Dr. Traquair and the Rev. Thomas Brown for so kindly placing specimens at my disposal, and to my colleague Mr. B. N. Peach for the excellent drawings accompanying these notes.

#### DESCRIPTION OF PLATE XX.

##### *Myalina crassa*, Fleming.

- Fig. 1.* Left valve, natural size. Cults Lime-works, near Pitlessie, Fife. *a*, hinge-plate with cartilage-furrows; *b*, scars of origin of the anterior muscular impression divided by the median ridge; *c*, scar of the insertion of the anterior adductor of the opposite valve; *d*, hollow depression or pit in the angle between the hinge-line and the anterior end; *e*, groove running from *d* across the hinge-plate; *f*, pallial line, with pits for the muscular fibres of the mantle.
- Fig. 2.* Right valve, natural size. Cults Lime-works. *a*, *b*, *c*, & *f* similar to *fig. 1*; *g*, raised border bounding the anterior muscular scars.
- Fig. 3.* ? Posterior portion of the shell, showing a strong muscular scar, natural size. Cults Lime-works.
- Fig. 4.* Small left valve, exterior view, natural size. Woodhall, water of Leith; cabinet of Dr. Traquair.
- Fig. 5.* Interior view of the same.

##### *Schizodus Salteri*, R. Etheridge, jun.

- Fig. 6.* Right valve, exterior view, natural size. Ardross, Fife; cabinet of the Rev. T. Brown.

- Fig. 7.* Left valve, exterior view, natural size. Woodhall, water of Leith; cabinet of Dr. Traquair.
- Fig. 8.* Interior view of *fig. 7*: *a*, central undivided tooth; *b*, anterior tooth; *c*, elongated posterior tooth; *d*, anterior adductor scar; *e*, posterior adductor scar; *f*, pallial line; *g*, internal oblique ridge.
- Fig. 9.* Right valve, interior view, natural size. Woodhall, water of Leith; cabinet of Dr. Traquair. *a*, large anterior tooth; *b*, elongated posterior tooth.

## BIBLIOGRAPHICAL NOTICE.

*Fossil Inland Shells from Dalmatia, Croatia, and Slavonia.* By SPIRIDION BRUSINA, Director of the Zoological Department of the National Museum of the Triune Kingdom, &c. &c. German enlarged edition of the Croatian Memoir in the "Rad" of the South-Slavonian Academy of Sciences and Art at Agram. 8vo, pp. 144, with 7 plates. Agram: 1874. (Fossile Binnen-Mollusken aus Dalmatien &c.)

THE collection of fossils here described and illustrated consists of 20,000 specimens, from about 30 localities, carefully enumerated. There are 139 species (109 Gasteropoda and 30 Conchifera), of which 49 are either new or were little known, and 11 are now much more fully determined than heretofore. Only 10 require either better preserved specimens for illustration or further books of reference for the author to make his determinations certain, namely:—*Hyalina*, 1; *Helix*, 1; *Limnæa*, 2; *Planorbis*, 3; *Pisidium*, 1; *Dreissena*, 2 species. Of the remaining 129, 13 are still living in Dalmatia, Croatia, or Slavonia, namely:—

*Melanopsis Esperi*, *Fér.*  
 — *aeicularis*, *Fér.*  
*Lithoglyphus fuscus*, *Zieg.*  
*Bythinia tentaculata*, *L.*  
*Valvata piscinalis*, *Müll.*  
*Neritina danubialis*, *C. Pfeif.*  
*Succinea elegans*, *Risso.*

*Succinea oblonga*, *Drap.*  
*Helix pomatia*, *L.*  
*Ancylus lacustris*, *L.*  
*Sphærium lacustre*, *Müll.*  
*Pisidium amnicum*, *Müll.*  
*Dreissena polymorpha*, *Pall.*

And 4 live still in other parts of Europe:—

*Melanopsis præmorsa*, *L.*  
 — *costata*, *Fér.*

*Melanopsis maroccana*, *Chem.*  
*Hydrobia stagnalis*, *Bast.*

The remaining 112 species are extinct; and of these, 24 had been already described by Brongniart, Partsch, Férussac, Krauss, Fuchs, Bielz, Braun, Thomæ, Hörnes, and others; whilst 41 have been described mostly by Neumayr in 1869, and by Brusina in this memoir. The distribution of the species in the Three Kingdoms, and their relationship to recent forms, are carefully shown.

The following appear to have continued from the Miocene brackish-water beds :—

Melania Escheri, <i>Brongn.</i>	Neritina picta, <i>Fér.</i>
Melanopsis inconstans, <i>Neum.</i>	Helix turonensis, <i>Desh.</i>
— Bouci, <i>Fér.</i>	— pomatia, <i>L.</i>
— vindobonensis, <i>Fuchs.</i>	Dreissena polymorpha, <i>Pall.</i>
Neritina nivos, <i>Brus.</i>	

From the Miocene freshwater beds :—

Melania Escheri, <i>Brongn.</i>	Bythinia croatica, <i>Brus.</i>
Melanopsis præmorsa, <i>L.</i>	Neritina callosa, <i>Meneg.</i>
— Esperi, <i>Fér.</i>	Dreissena Fuchsi, <i>Pilar.</i>
— acicularis, <i>Fér.</i>	— triangularis, <i>Partsch.</i>
— impressa, <i>Krauss.</i>	— balatonica, <i>Partsch.</i>
Hydrobia stagnalis, <i>Bast.</i>	

From the Pliocene Congeria-beds :—

Hydrobia stagnalis, <i>Bast.</i>	Valenciennsia annulata, <i>Rousseau.</i>
Bythinia tentaculata, <i>L.</i>	— Pauli, <i>R. Hörn.</i>
Vivipara bifurcata, <i>Bielz.</i>	Pisidium amnicum, <i>Müll.</i>

All the *other Dalmatian* species come from the Pliocene freshwater marl; and the *Croatian* and *Slavonian* from the freshwater Paludina-clays, which the author regards as different from the true Congeria-beds.

The relationships of all the fossil species with those now found in the several "Regions" defined by naturalists are fully treated of.

The genera under notice are :—

Ammicola (2 spp.).	Neritina (9).
Ancylus (1).	Pisidium (2).
Bythinia (3).	Planorbis (6).
Dreissena (11).	Prososthenia (4).
Emmericia, <i>nov. gen.</i> (2).	Pyrgula (2).
Fossarulus (3).	Sphærium (1).
Helix (5).	Stalioa, <i>nov. gen.</i> (2).
Hyalina (1).	Succinea (2).
Hydrobia (5).	Unio (20).
Limnæa (4).	Valenciennsia (3).
Lithoglyphus (2).	Valvata (3).
Melania (1).	Vivipara (28).
Melanopsis (24).	

Descriptions of the 139 species, and of some genera in particular, follow, illustrated by the seven lithographic plates.

In an appendix, on the shells found in the Congeria-beds of Agram, Sp. Brusina treats of additional species belonging to

Ampullaria (1).	Lithoglyphus (1).
Cardium (17).	Melanopsis (2).
Cyclostomus (1).	Micromelania, <i>nov. gen.</i> (5).
Dreissena (3).	Planorbis (3).
Hydrobia (1).	Pyrgula (1).
Limnæa (2).	Valvata (3).

The author has worked *con amore* and to good purpose. He shows his results often in useful tables and classified lists. The printing of the memoir is good; and the lithographs are bold, careful, and natural, though somewhat poorly printed.

## MISCELLANEOUS.

*Otenodus cristatus.*

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

Leeds, May 3, 1875.

GENTLEMEN,—I am very willing to be corrected by Mr. Atthey; and this letter is to be regarded as in the main a request for further information.

In Messrs. Hancock and Atthey's original paper (*Nat. Hist. Trans. N. & D. vol. iii. p. 61*), and again in Mr. Atthey's note ('*Annals*,' May 1875), the *upper* surface of the palatal tooth of *Otenodus cristatus* is said to be concave. I have always understood this to be their proposition, and controverted it by stating that in the example now in the Leeds Museum the *lower* surface is concave. No specimen which I have seen shows the upper surface of the tooth; nor have I hitherto mentioned it. If the upper surface be concave, the lower or exposed surface would be convex, unless it be contended that the tooth has greatly thickened edges, which is not actually the case. Is it possible that Mr. Atthey has mistaken the upper for the under surface? If so, I may well have failed to catch his meaning.

I have never been satisfied that the distinction between *C. cristatus* and *C. tuberculatus* was well founded; but I readily admit that I ought either to have stated this explicitly, or to have cited Messrs. Hancock and Atthey's statement in their own language. Criticism of proposed species, however, was no part of my plan.

If Mr. Atthey will assure us that he can substantiate by indisputable specimens the restoration, *Nat. Hist. Trans. N. & D. vol. iv. t. xiv.*, I am prepared to accept his statement, notwithstanding its *primâ facie* improbability.

Your obedient servant,

L. C. MIALL.

*Observations on the Period of the Extinction of the ancient Fauna of the Island of Rodriguez.* By M. ALPH. MILNE-EDWARDS.

The imperfect knowledge we possess of the ancient fauna of the island of Rodriguez, and the unexpected facts discovered by the palæontological study of the bones collected from the caves there, give real importance to all the authentic information we can find in the accounts of the old travellers on the productions of that island. François Leguat, who staid at Rodriguez from 1691 to 1693, and published some very careful observations on all he had seen there, described its plants and animals. Most of his assertions have been corroborated by the palæontological discoveries recently made; and, in several memoirs which I have had the honour to present to the Academy, I have made known the zoological characters of some birds mentioned by Leguat, and of which the species have entirely disappeared. But at what period did this extinction take place? and to what cause was it due? To resolve these questions we had no certain guide. We are now acquainted with another document

of great value, completing up to a certain point the indications given by Leguat, and nearly forty years subsequent to his narrative.

It is a manuscript found in the Ministère de la Marine, entitled "Relation de l'île Rodrigue." It was discovered by M. Rouillard, a magistrate of Mauritius, who was making some special investigations in these archives. I was informed of this fact by Mr. Alfred Newton\*, Professor at the University of Cambridge; and he requested me to search in the archives of the ministry in order to settle the time when this document was written; for it bears no date and no author's name, and is bound up together with other manuscripts in vol. xii. of the 'Correspondance de l'île de France,' année 1760. Is this date the correct one? and may we conclude that the birds in question were still living in 1760—that is to say, scarcely more than a hundred years ago?

I am convinced that this document is older than those with which it has been combined; and if I have not been able to discover its author, I have been able to fix its period. In fact I found in vol. i. of the 'Correspondance générale' an old inventory of reports and letters, from 1719 to 1732, contained in the portfolios of the office before they were collected and bound in volumes. In this enumeration is found our 'Relation de l'île Rodrigue' intercalated between some documents of the date 1729 and others of 1730 and 1731. Its inventory number corresponds exactly to that found on the 'Relation' itself; it is "No. 1, Carton 29." This indication therefore enables us to establish precisely, if not the time when the report was written, at least when it was transmitted to the Compagnie des Indes. It is, then, anterior to 1730, and it was by mistake that it was bound up with the Correspondence of 1760.

I should moreover remark that, according to the above-mentioned inventory, Carton No. 29 must have also contained a "deliberation of the Council" (of the Compagnie des Indes), "July 20, 1725, as to taking possession of the island of Diego Ruys"—that is, of Rodriguez. There is consequently reason to suppose that after the deliberation the Company commissioned one of its officers to go and study the resources of the island, and find out if it was advisable to make a settlement there. Our 'Relation,' transmitted four years after, seems to answer completely questions of this sort. The unknown author of the report first gives all the information necessary to facilitate the landing, indicating all the islets and reefs; he then reviews the animal and vegetable productions, and has not forgotten the survey of the soil and its arable qualities.

This account permits us to affirm that forty years after Leguat's departure the fauna of Rodriguez still included all the interesting ornithic types described by him, and that their extinction was subsequent to that date. It also gives us details of the habits, forms, and colours of several species of which I had recognized the existence and zoological affinities from their bones alone; and it confirms the results at which I had arrived.

\* Prof. A. Newton presented to the Zoological Society of London, at its meeting on the 19th January, 1875, some extracts from the 'Relation.'

It takes up in succession the solitaire and the birds I made known under the names of *Erythromachus Leguati*, *Ardea megacephala*, *Athene murivora*, and *Necropsittacus rodericanus*\*. The 'Relation' shows distinctly that the ornithic fauna of the island did not undergo any notable modification during the first part of the 18th century, since the species mentioned by Leguat were still existing in 1730; while we know that in 1761, when the astronomer Pingré staid there, the solitaires had become so rare that Pingré speaks of them only from hearsay, having never observed them himself. It gives no indication about the other land-birds. We have therefore reason to think that extinction of these species, commenced probably at the time of Leguat's stay, proceeded with ever increasing rapidity, and must have reached its maximum between 1730 and 1760. The documents collected at the Ministère de la Marine leave but little doubt on the subject; and, thanks to them, we can not only, so to speak, be present at the destruction of one group of animals which was formerly extremely abundant at Rodriguez (I mean the land-tortoises), but also well account for their disappearance. The causes which brought about their extinction are, according to all probability, those which annihilated the birds.

In the reports addressed to the Compagnie des Indes, preserved in the archives of the Ministère de la Marine, we see that the island of Rodriguez was regarded as a sort of provisioning-store, not only for the Isle of France and the island of Bourbon, but also for the ships frequenting those parts. They came there regularly for tortoises. Already, in 1726 or 1727, M. Lenoir, during his visit to the Isle of France, wrote to the council of the Company:—

"Vessels going to and returning from India must not be suffered to go and carry off without discretion the land-tortoises from the neighbouring islets; and the captains must be forbidden to send their boats to take them without apprising the commandant of the island of the fact, and of the number they intend to take away" †.

Butcher's meat was often deficient at the Isle of France; and we find that a regular provisioning-service was gradually organized at Rodriguez. The various governors frequently sent ships, which returned loaded with tortoises, and had no other destination. In 1737 M. de la Bourdonnais ordered some expeditions of this kind; but he did not keep an exact account of them, and we cannot judge of their importance. On the other hand, M. Desforge-Boucher, in his reports addressed to the Company in 1759 and 1760, enumerates not only the ships he employed on this service, but also the number of tortoises collected and brought away by each of them. Four small vessels, 'la Mignonne,' 'l'Oiseau,' 'le Volland,' and 'la Pénelope,' were at that time appropriated almost exclusively to this traffic; and an officer resided at Rodriguez to superintend them. I have not space to quote the extracts from the journal of Governor Desforge-Boucher where he speaks of these expeditions; it will suf-

\* The portions of the 'Relation' which refer to natural history will be published in the 'Annales des Sciences Naturelles.'

† MS. documents collected under the title of "Code de l'île de France," 1756 to 1768 (Archives de la Marine).



rice to say that, according to the abstract which I have made of the account (probably incomplete) he kept of the arrivals, he caused to be removed from Rodriguez more than 30,000 land-tortoises in less than eighteen months. When we reflect on the small extent of the island, we cannot be surprised that these animals, formerly so common, have entirely disappeared; notwithstanding their fecundity, they could not withstand such means of destruction.

That which we have stated concerning the tortoises must have taken place also with the land-birds. It is evident that the sailors would not abstain from pursuing and killing them. Those species whose undeveloped wings rendered them easy to capture, while the delicacy of their flesh made them sought after, must have been rapidly exterminated. It is therefore unnecessary, in order to account for their extinction, to invoke changes in the biological conditions; the action of man was amply sufficient, and was exerted there without impediment and with more facility than anywhere else. It is still going on in many other parts of the globe; and we can already foresee the period when many wingless birds, large Cetacea, and certain species of seals and otaries will have been annihilated by man.—*Comptes Rendus de l'Académie des Sciences*, May 10, 1875.

*On the Development of the Pteropoda.* By M. H. FOL.

The vitellus of the Pteropoda before fecundation is histologically a simple cell with a deposit of nutritive matter in its interior. This fecundated vitellus is destitute of membrane and nucleus. It is composed of a formative or protoplasmic portion and of a nutritive portion composed of a network of protoplasm, in the meshes of which the nutritive globules occur. In the centre of the formative part there is a star formed by the granules of the protoplasm arranged in diverging straight lines. The rays of this star stretch to the limit of the formative portion; and the nutritive globules arrange themselves in lines.

After the egress of the so-called corpuscle of direction, a nucleus appears in the centre of the star, which is effaced in proportion to the growth of this nucleus. The granules and the globules of the vitellus cease to be in lines. Before each segmentation the nucleus disappears, to be replaced by two molecular stars which originate in its interior. The centre of each of these stars may be regarded as a centre of attraction; and all the vitelline substance obeys this attraction. After segmentation, a nucleus reappears in the middle of each star, and the vitelline substance remains at rest.

The result of segmentation, which differs little from the recognized types of the Gasteropods, is the development of a nutritive portion, composed of three large spheres, and of a formative moiety, of transparent spherules. Afterwards the nutritive cells divide, producing a superficial layer of little cells, which in the end envelop the three large nutritive spheres and constitute the ectoderm. The fourth of the large central spheres, entirely composed of protoplasm, divides completely and causes a thickening of the ectodermic layer. This region corresponds to the lower extremity of the larva. The line of junction of the three nutritive spherules coincides with the oral-

aboral axis of the larva. The ectoderm closes up in the last place at the point of union of the three spheres, a point which may coincide either with the aboral or with the oral pole of the larva. I am in favour of the latter alternative.

The embryonic development of the Gymnosomes forms a transition between that of the Thecosomes, which I have just recapitulated, and that of the Heteropoda, between the formation of the embryonic lamellæ by envelopment and their formation by invagination.

The digestive cavity is formed by a simple differentiation of the mass of nutritive or central cells. From this results a completely closed trilobate cavity. From the median lobe proceeds the digestive tube; from the lateral lobes the nutritive sacs. The cells composing the walls of this cavity descend directly from the nutritive or central cells of the embryo; they are small and numerous round the median cavity; cuneiform, and composed in great part of nutritive substance round the lateral cavities. The median portion lengthens to form the stomach and the intestine. An invagination of the ectoderm, starting from the point where this lamella has closed up, descends to meet the stomach, with which it unites. This invagination represents the mouth and œsophagus; the point of junction the cardia. It represents in front a diverticulum which gives origin to the radula. This development of the digestive tube agrees point by point with what we know of the development of the Rotifera.

The first cilia which appear are motory; they are in small tufts on a circular zone on a level with the mouth; then a band of small cilia grows below the larger ones and serves to convey the nutritive particles to the mouth.

The foot has its origin in a thickening of the ectoderm, which occupies the greater part of the ventral surface of the embryo. It afterwards takes the form of a hump, and then that of a horizontal tongue, which sometimes bears an operculum on its lower side. It divides into a median lobe and two lateral ones, which become the swimming-organs.

The pallial cavity is formed by sinking-in of the ectoderm between the edge of the shell and the neck of the larva, always on the right of the anus whatever may be the position of the latter.

The larvæ of the Pteropoda have two contractile sinuses, situated the one at the foot and the other in the dorsal region, which send from one to the other the liquid contained in the cavity of the body. Neither of these sinuses can be compared to those of the embryo of the *Limaces*. The cephalic sinus of the *Limaces* corresponds to all the median portion of the velum and to the whole dorsal region of the embryos of the Pteropoda. The contractile sinus of the foot of the *Limaces* is situated at the extremity, and not at the base of the foot as in the Pteropoda.

The kidney is formed at the expense of the ectoderm, and the heart by the differentiation of a mass of cells of the mesoderm. The internal aperture of the renal canal opens outside the heart and into the pericardium when the latter is afterwards formed. The kidney beats with almost as much vivacity as the heart. The aorta and the arteries are formed by the differentiation of chains of mesodermic cells.

The walls of the stomach are differentiated into two layers—an external one of muscular fibres, and an internal mucous layer; this latter produces five horny teeth, preceded sometimes by the appearance of a single larval plate. The vitelline sacs, of which there are two at first, unite into one in the Orthoconcha. This sac, which opens into the dorsal part of the stomach, is absorbed and diminishes rapidly in the Hyaleaceæ; on the contrary, it is developed in the Styliolaceæ and the Cresceideæ, where it seems to play, provisionally, the part of the liver. In every case it diminishes in proportion as the liver is developed. The liver is composed of small diverticula of the wall of the stomach. The nutritive sacs have nothing to do with the formation of this organ.

The otcysts are formed early, in the midst of a layer produced by a doubling of the ectoderm still composed of large embryonic cells. The otolith originates in the thickness of the wall of the vesicle, and falls afterwards into its cavity. In the *Limaces* and the Cephalopoda the otcyst is formed by an invagination of the ectoderm already composed of very small cylindrical cells. The size of the embryonic cells of the generative layer seems to be in this case, as in many others, the cause which determines the mode of formation of an organ by invagination or by simple folding.

The nervous system is composed of a cephalic nervous mass and of a subœsophageal mass. The former is formed by a double invagination of the ectoderm of the cephalic region in the area circumscribed by the velum; the mode of formation of the second has not been observed in the Pteropoda.

The appearance of the shell is preceded by the formation of an invagination of the ectoderm a little in front of the aboral pole. This preconchylian invagination turns round; and the first rudiment of the shell appears on the projection thus formed. In exceptional or abnormal cases this invagination does not turn round, or rather it is reformed after having disappeared. Its existence is incompatible with that of an external shell and *vice versa*. It is the point of departure of the band which secretes the shell ring by ring, and which becomes the margin of the mantle. The first part of the shell, that which the larva inhabits, often differs from the portion which is added later on; it may persist, fall or break off; and it has furnished me with characters which have enabled me to subdivide the sub-order of the Thecosomatous Pteropoda. The existence of the preconchylian invagination cannot be satisfactorily explained by purely physiological causes; it seems, then, to have hereditary causes, and may morphologically be compared to the conchylian invagination of the mollusks with internal shells, which invagination I have studied in *Sepiola* and the *Limax*. The existence and signification of that invagination in the Cephalophora, the Cephalopoda, and the Lamelibranchiata have been gradually cleared up by Lereboullet, Semper, Salensky, Ray Lankester, and myself.

The sexual products originate at the expense of the endoderm. Sexuality can only be attributed to one embryonic lamella.—*Comptes Rendus*, January 18, 1875, p. 196.

Notes on an Examination of four Species of Chitons, with Reference to Posterior Orifices. By WILLIAM H. DALL.

1. *Stimpsoniella Emersonii*.

Two specimens.

The large and fine specimen from the Gulf of St. Lawrence presented a posterior and terminal anus of large size, but with the edges not elevated into a papilla. The head of an ordinary pin could be inserted into it without violence.

The orifices of the ovaries, bilaterally symmetrical, were situated just behind, and, as it were, under the shadow of, the last branchia on each side. There were two fenestræ on each side of the anterior, a little further towards the girdle and a little larger than the posterior.

This species resembles in most particulars the *Symmetrocephyrus Pallasii* of Middendorff; and it would seem that his ungainly sub-generic or generic name should be adopted. The hairs are precisely similar in both species, as are the branchiæ. The insertion-plates also agree, according to Dr. Carpenter, who examined a series from a specimen obtained by me in the Aleutian Islands. The principal differences, besides the larger size of *S. Pallasii*, are as follows:—In the latter the hairs are more closely set, the texture of the epidermis is thicker and harder, the points of the valves are more nearly covered, and the skin is smoothly rounded over the back, not showing any thing of the form of the valves as is the case in *S. Emersonii*. I think also the valves are smaller, in proportion to the size of the animal, in *Pallasii* than in *Emersonii*.

2. *Tonicella marmorea*, Fabr.

This species showed a clearly defined posterior and terminal vent. The fenestræ of the ovaries were symmetrical on each side; but the branchiæ pass behind them and conceal them. They are very small; and I could not detect more than one on each side, though fresh specimens, not hardened and contracted by alcohol, might show more.

3. *Trachydermon albus*, Linn.

The same remarks apply to this species. The vent was terminal, and on a papilla.

4. *Trachydermon ruber*, Linn.

Three specimens examined.

These specimens were much hardened by alcohol. Removing the plates from above and then the inner lining membrane, beneath the large and well-filled ovaries the intestinal canal is seen, terminating in the median line posteriorly. From the outside the anus was not perceptible in the smaller specimens. By carefully turning back the outer edge of the girdle in the largest specimen, after removing the posterior plates, but without touching the animal with the dissecting-knife, the anus was perceptible, with a pellet of feces impacted in the opening. It is very small, exactly in the median line behind, and not on a papilla. It is also a little higher up than in the other species. The "cancellated space" noticed by Mr. Emerton (as per notice in Ann. & Mag. Nat. Hist., March 1874, p. 121) on each side behind the branchiæ is a fold or groove containing the ovarian fenestræ. There were in this specimen three fenestræ on each side; but according

to Dr. Carpenter the number is variable, Prof. Verrill having counted from four to six in some specimens. These fenestræ in this species are more complicated than in most chitons which I have examined. I have never been able to satisfy myself that there is a true oviduct; and it may be that the ova are dehiscant in the perivisceral cavity, and may be expelled through the fenestræ, as they are through the analogous "oviducts or segmental organs" of brachiopods.

The fact that the ovarian openings are not simple apertures was noticed by me in dissecting chitons in 1869, but I am not aware that attention had been previously called to this fact *in print*. Their position had been previously known; but it is not uniform in all chitons. In some the fenestræ are close to the anus and single on each side; and it has been stated that the ovary of one side is sometimes abortive. This last I have not yet observed in any species which I have dissected.—*Bulletin of the Essex Institute*, vol. vi., Aug. 1874.

*"Boreal and Arctic Shells."*

We beg to call the attention of our readers to the following communication received from the Secretary to the Smithsonian Institution.

*To the Editors of the Annals and Magazin of Natural History.*

Smithsonian Institution,  
Washington, D. C., March 16, 1875.

DEAR SIRS,—Mr. W. H. Dall has been engaged since 1865, under the auspices of the Smithsonian Institution, in prosecuting researches in regard to the marine invertebrates of the region lying between America and Asia, from latitude 50° to latitude 70° N., including the coasts of Russian America, the Aleutian Islands, Behring Sea and Strait, and the Arctic Ocean north of the Strait. He is now occupied in working up his collections at the Institution, with special reference to correlating the species of the Arctic fauna, and their relation to those of both the Atlantic and Pacific seas.

The Smithsonian Institution is desirous of obtaining suitable material for his comparisons, especially from the coasts of Greenland, Spitzbergen, Norway, and Sweden, the northern coast of Russia, and, in general, the boreal seas of Europe. While any and all marine invertebrates will be acceptable, Mr. Dall at present is especially anxious to secure, as soon as possible, all the arctic and boreal species of Tunicates and of Shells, and especially such as contain the animal, either dry (if Gasteropoda) or preferably in alcohol, and for the commoner species large series and from as many different localities as possible.

In return for such contributions the Institution offers a series from Mr. Dall's very extensive collections, which will be supplemented, if necessary, by duplicates from the collections of the U.S. Fish Commission made on the east coast of the United States, and identified by Prof. A. E. Verrill and other collaborateurs of the Commission. Any valuable specimens which may be lent for examination will be carefully preserved, and returned at as early date as possible. Specimens may be sent through any of the European agents of the Smithsonian Institution.

Very respectfully,

JOSEPH HENRY, Secretary S. I.

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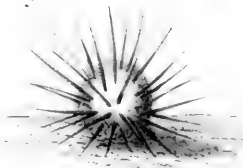
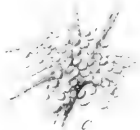
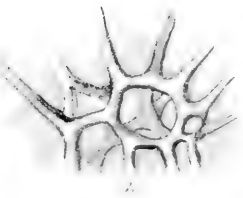
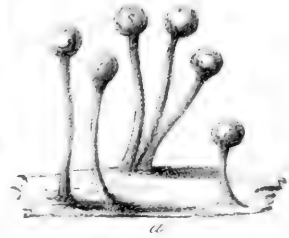
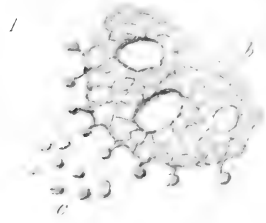
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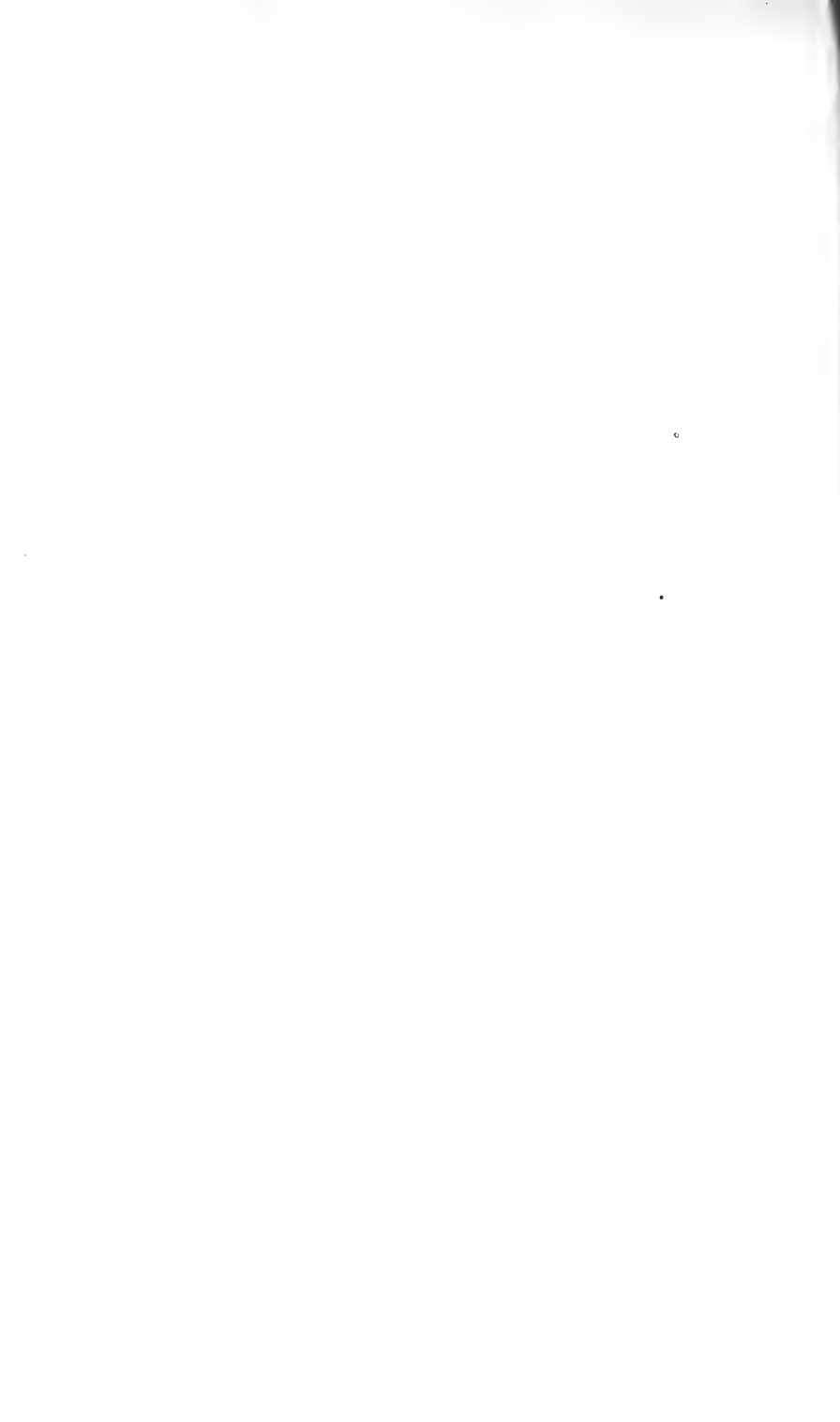


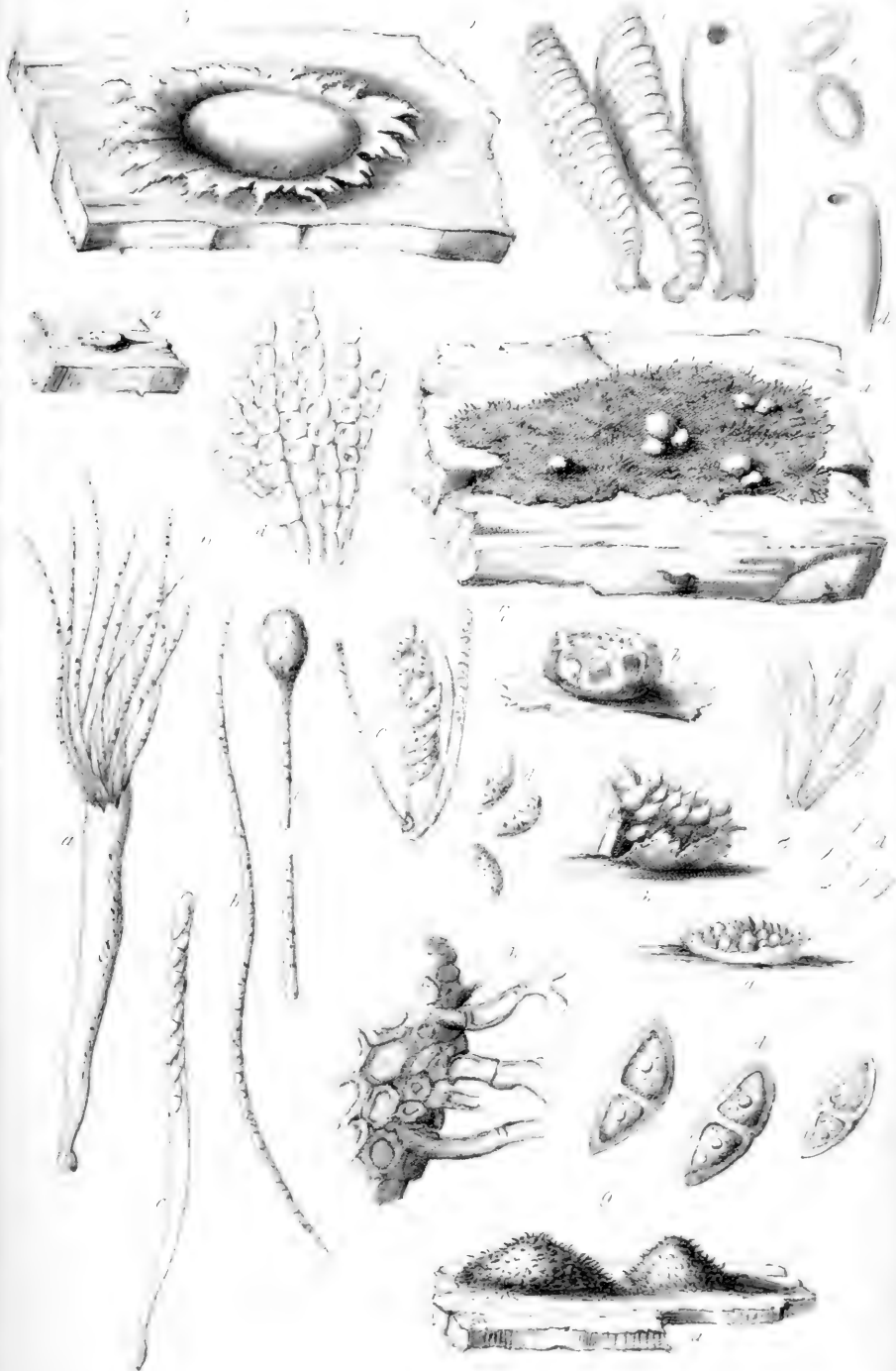
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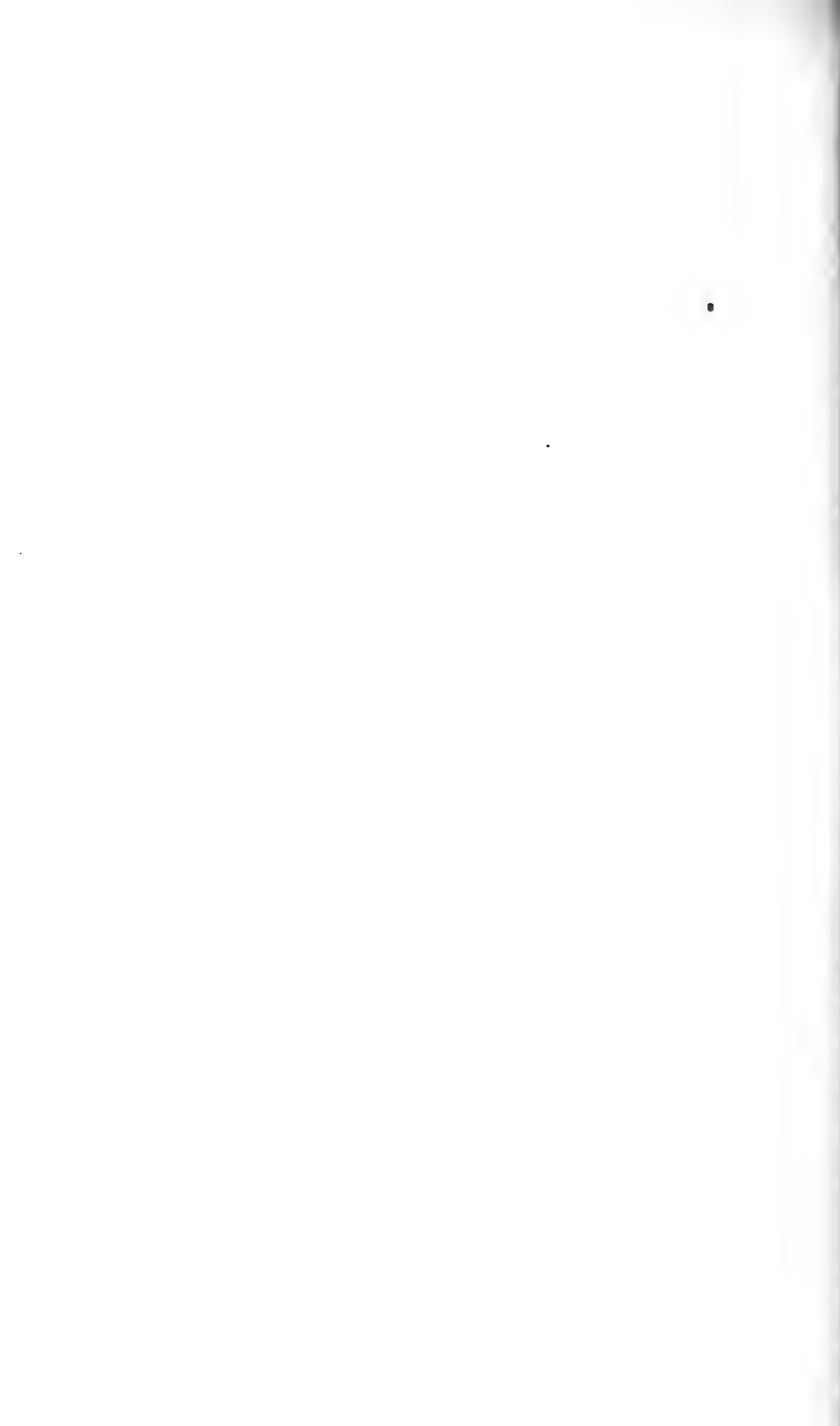
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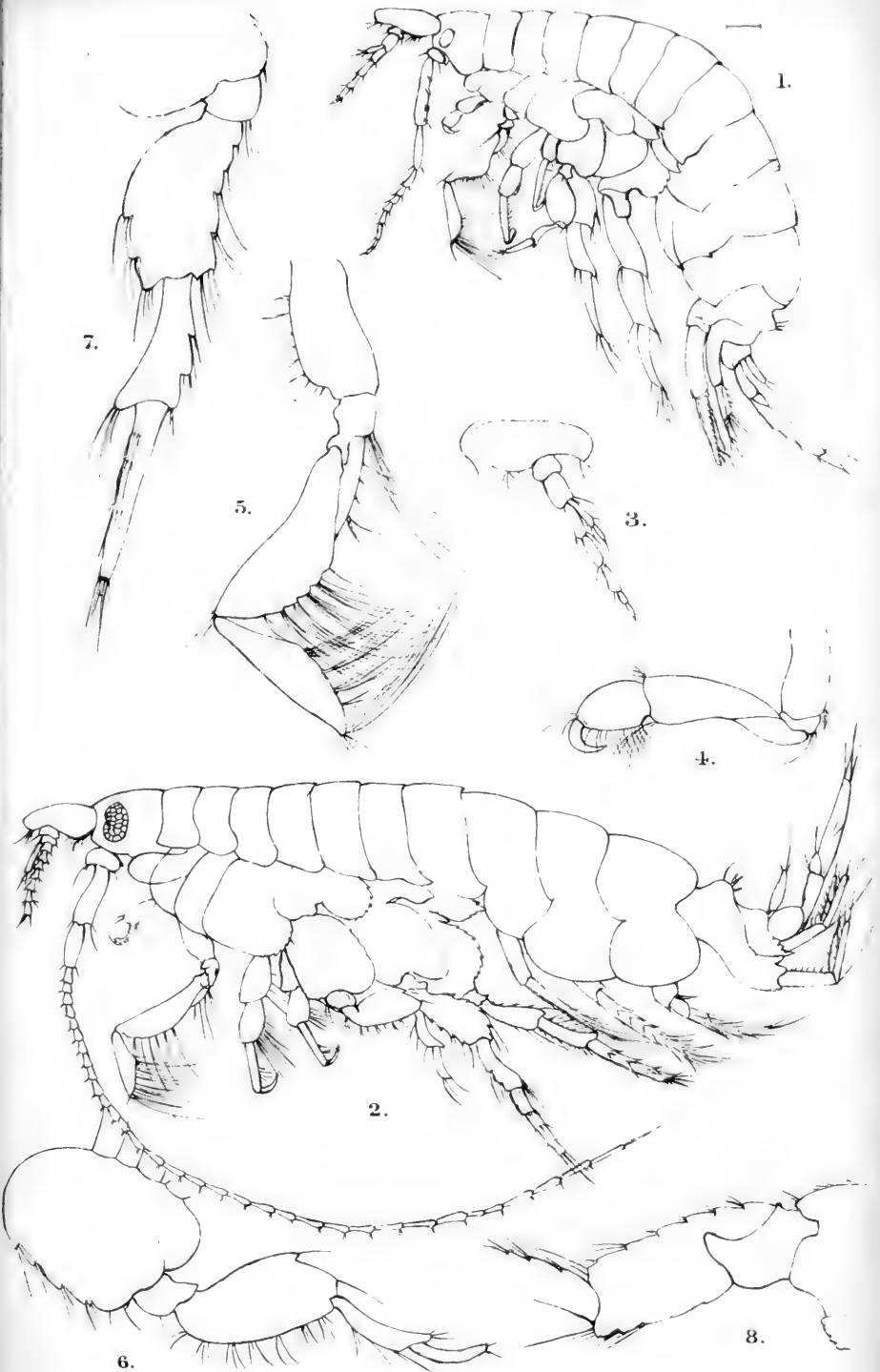
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A.



POTAMOCHERUS EDWARDSII

B.





Fig: 1.

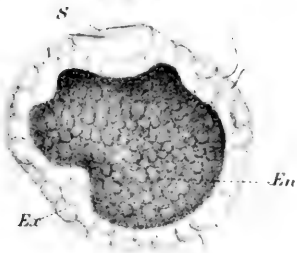


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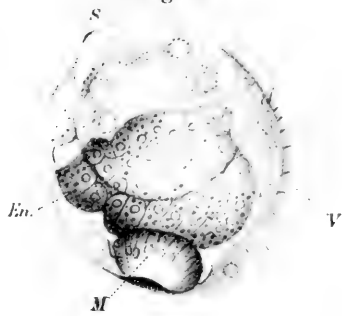


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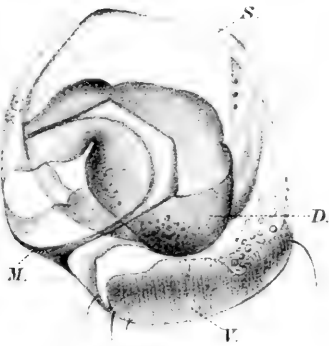


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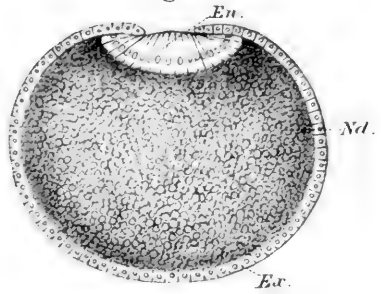


Fig: 4.



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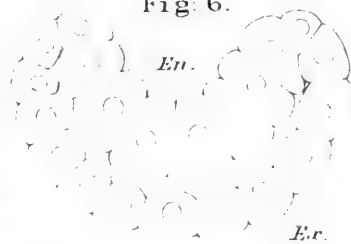
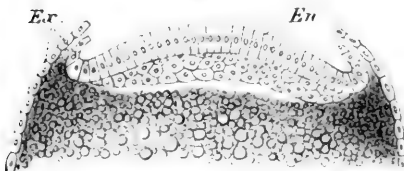
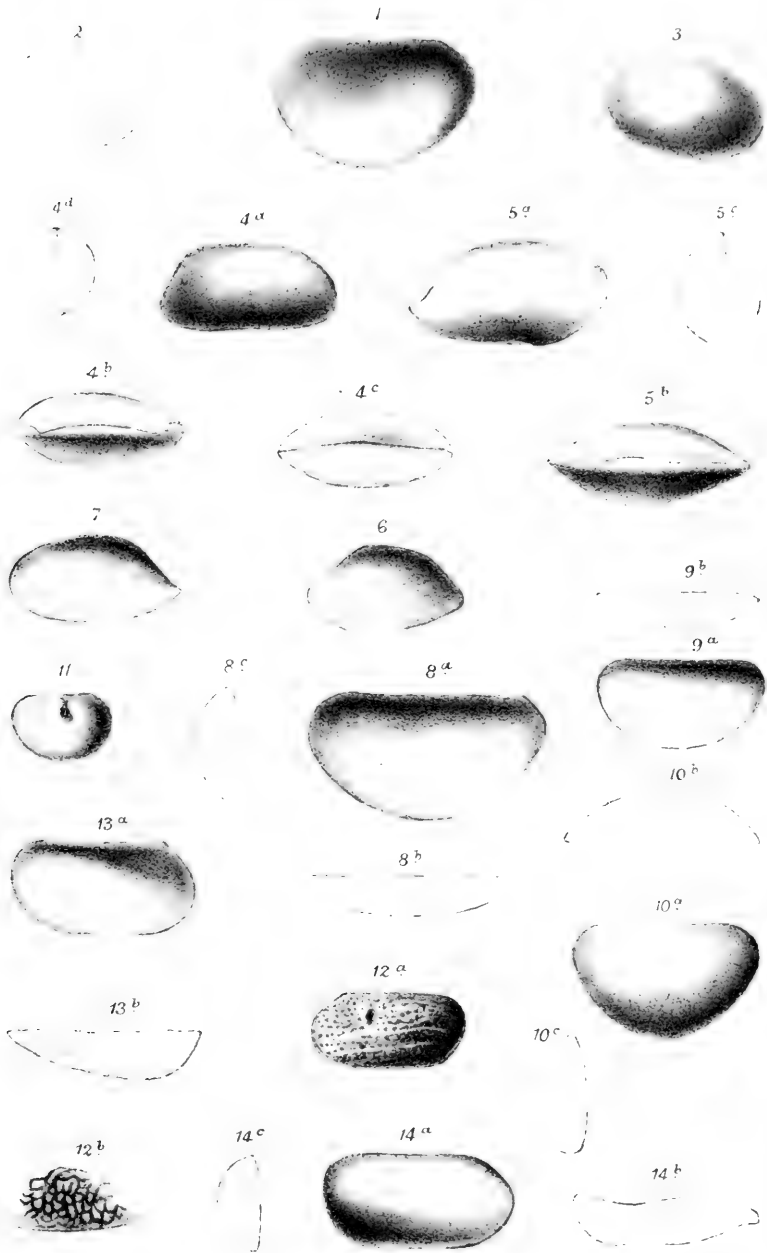


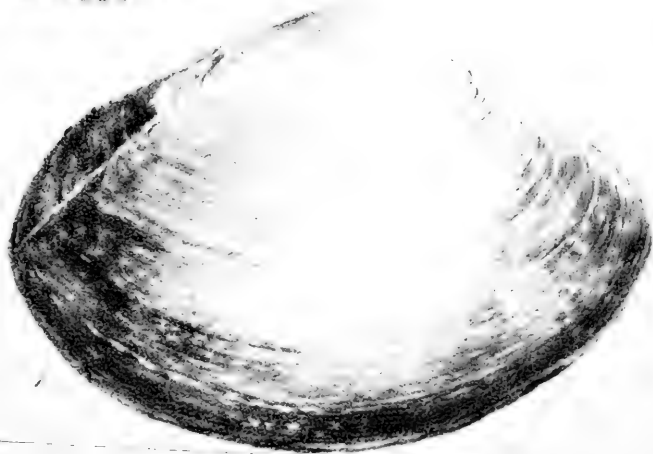
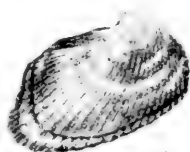
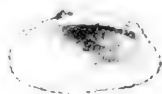
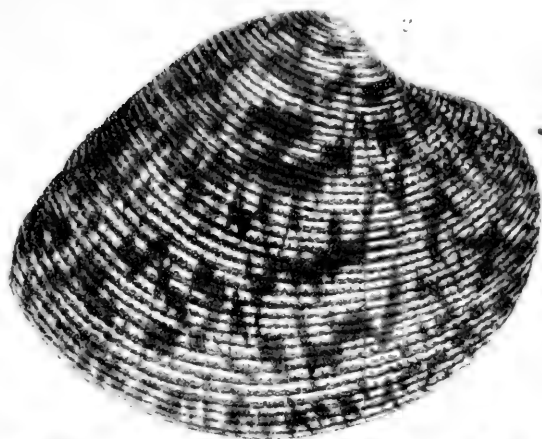
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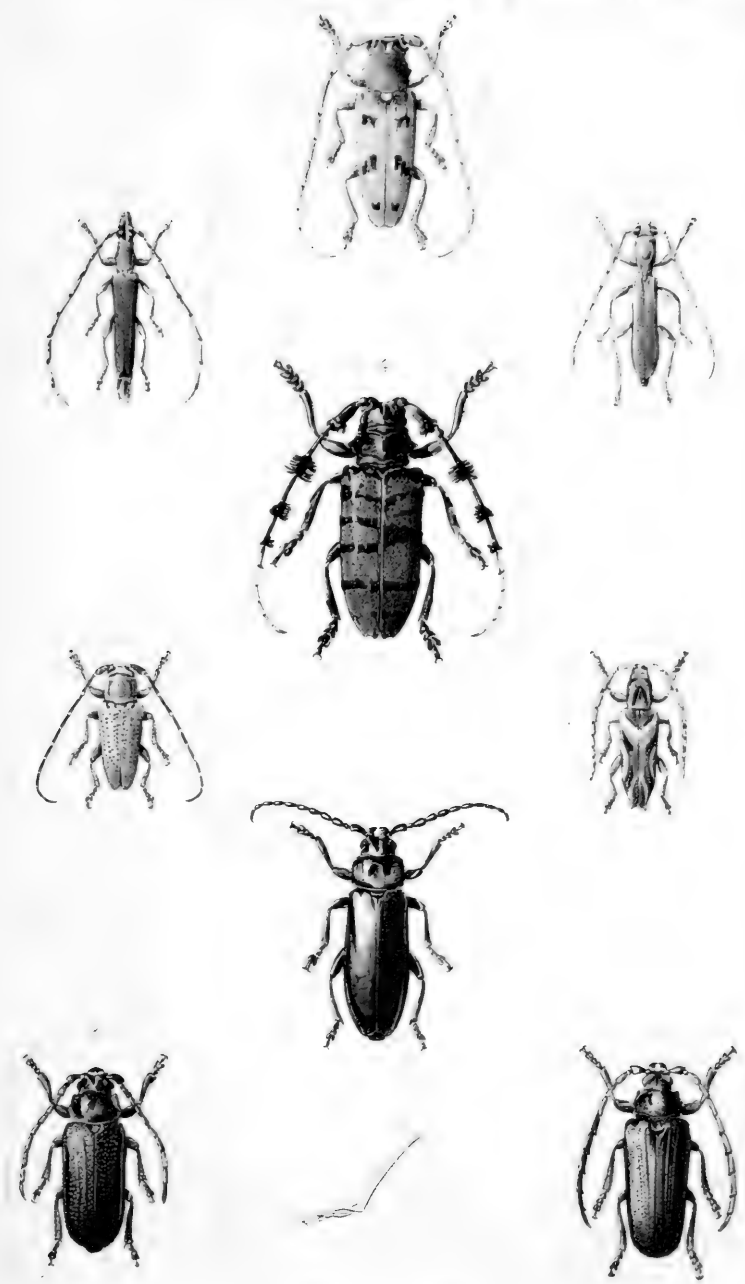


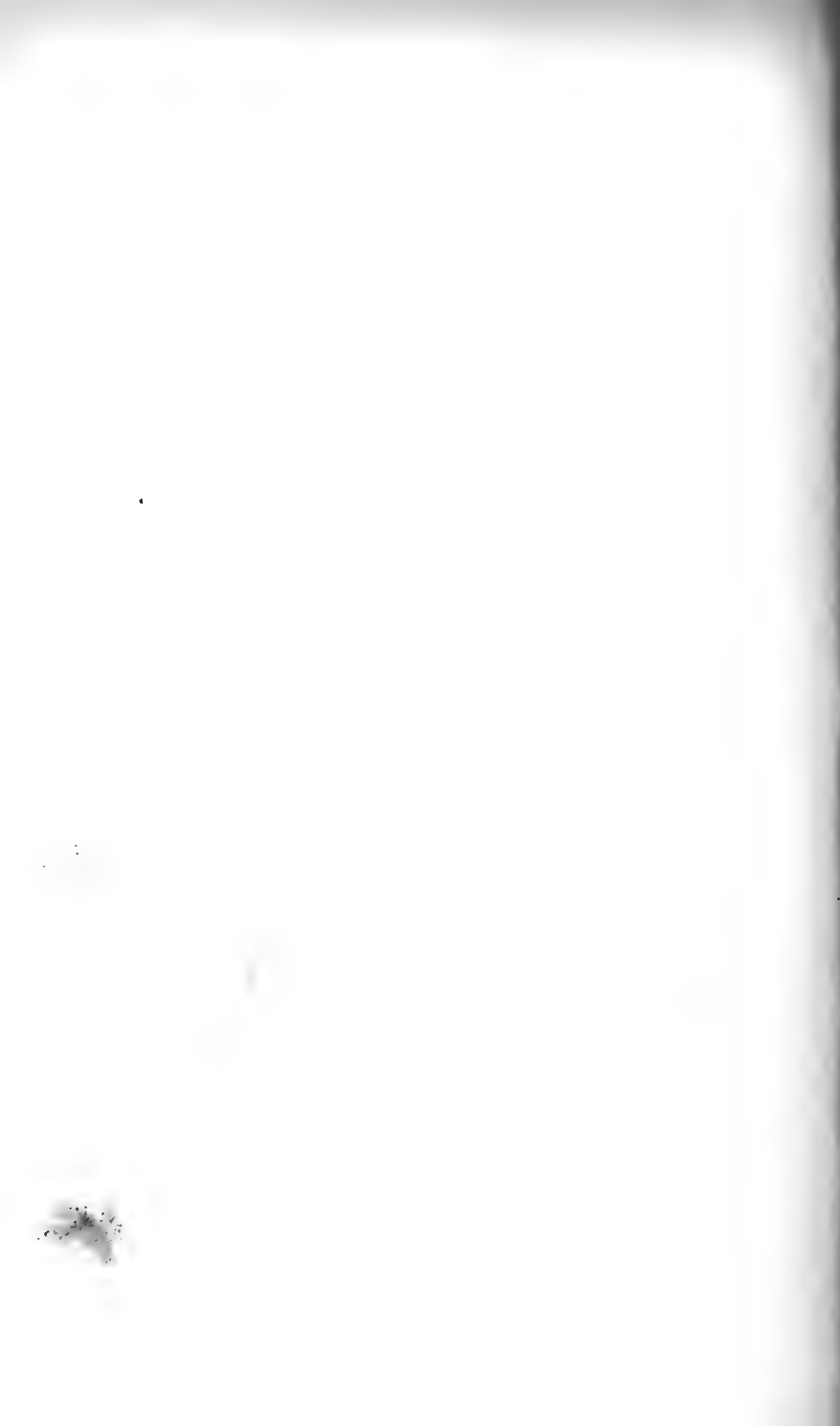
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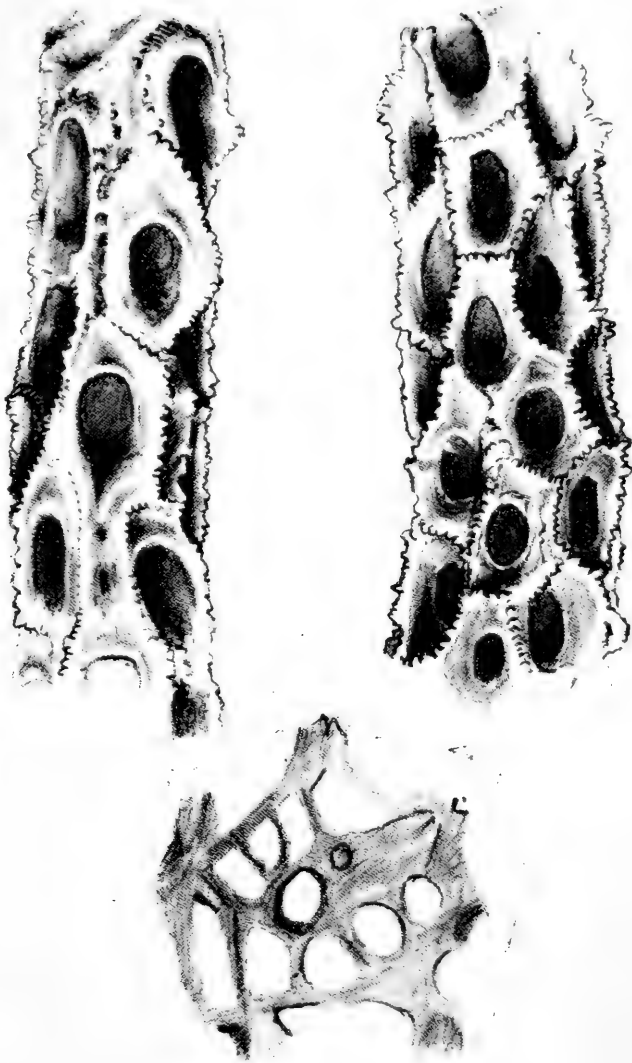
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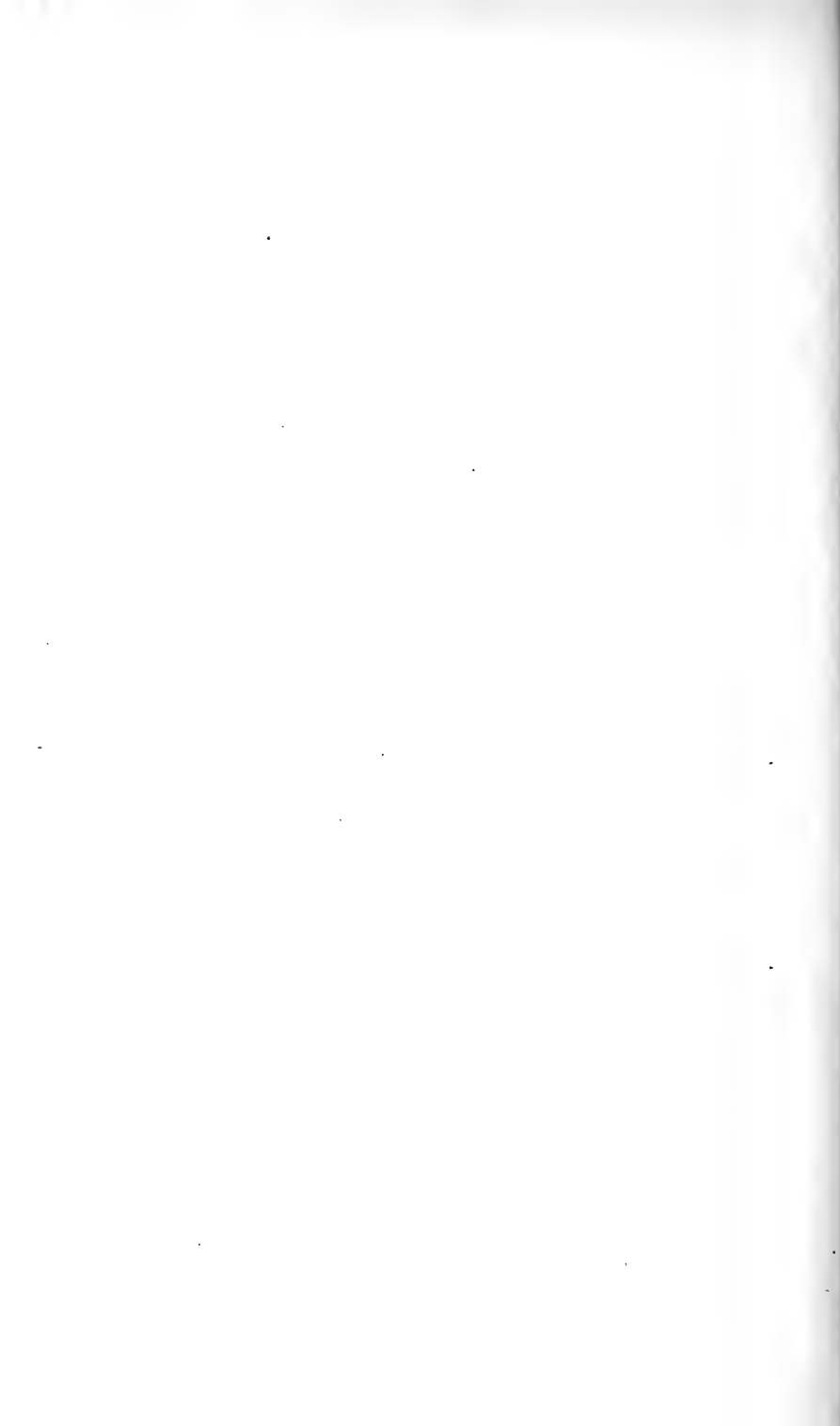


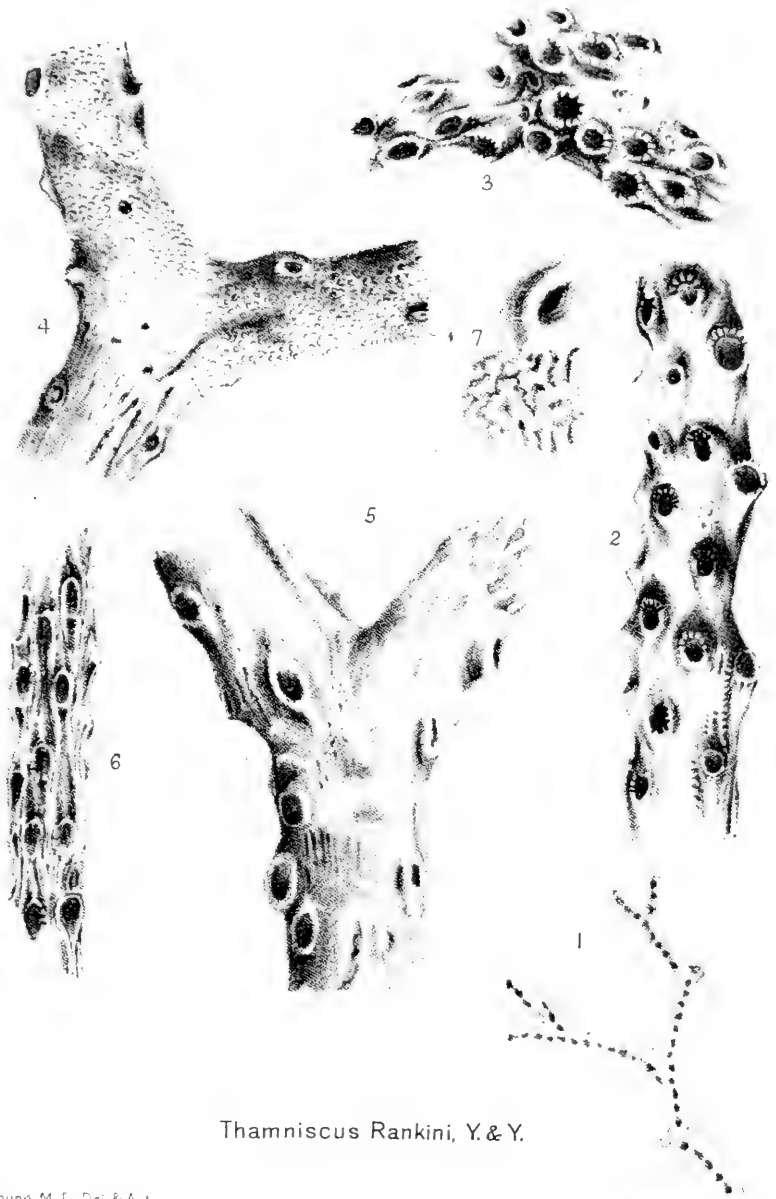






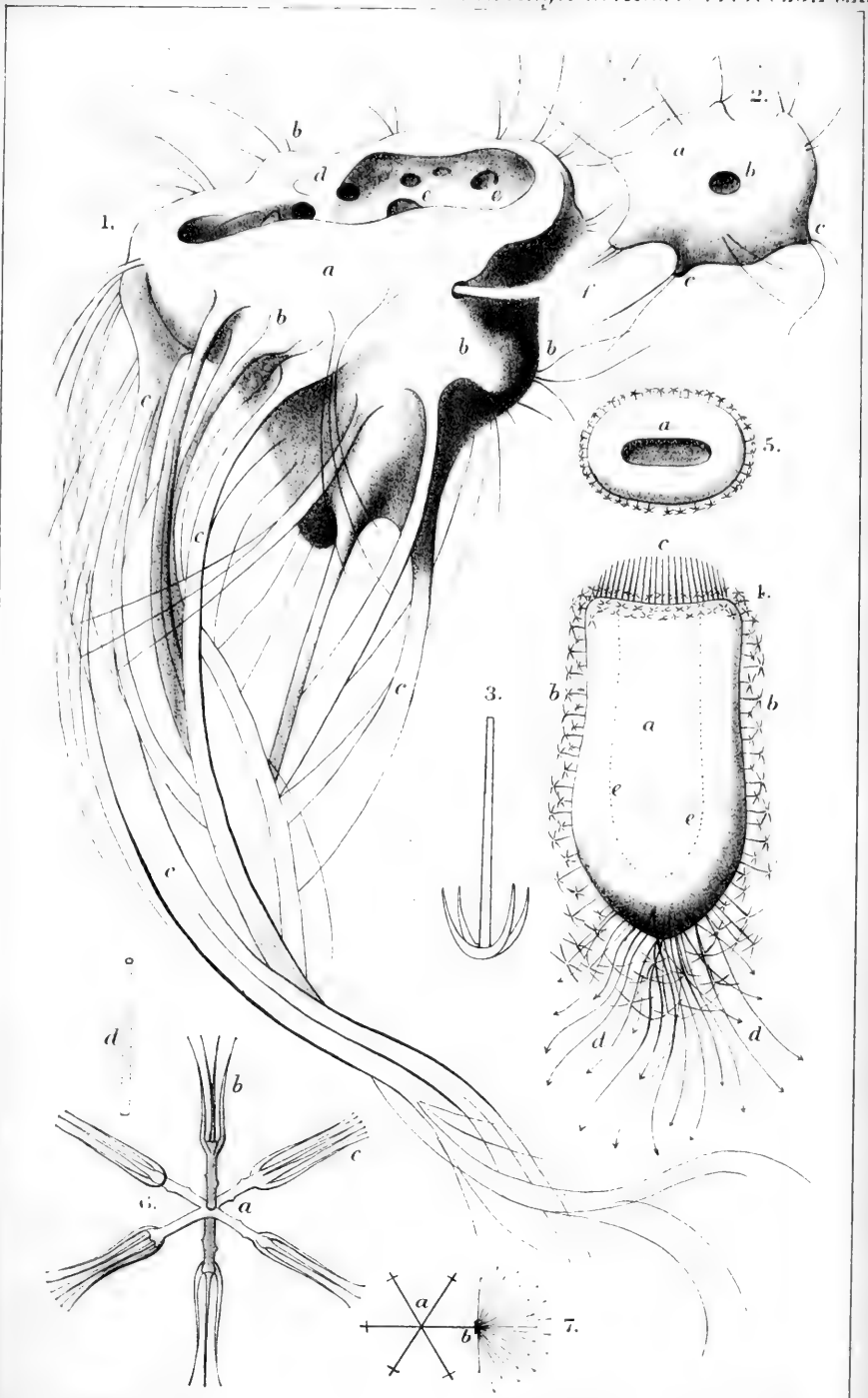
*Rhabdomeson rhombiferum Phil.*





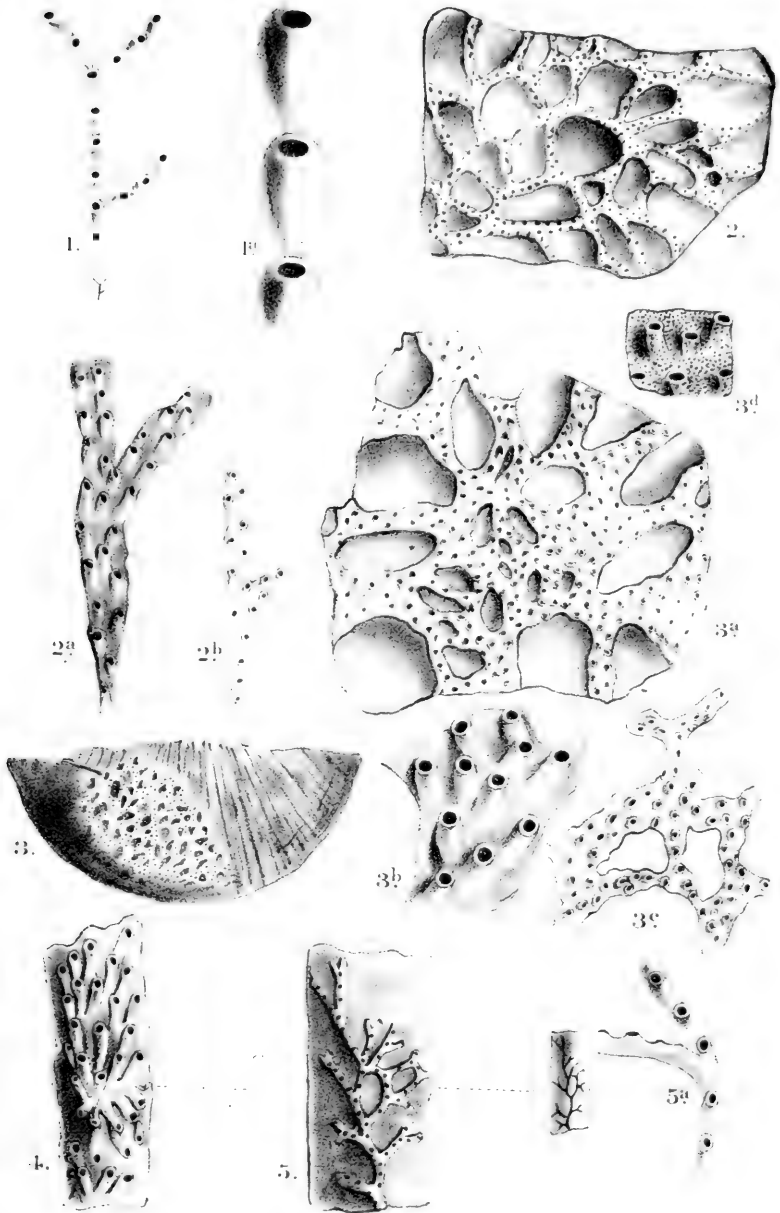
Thamniscus Rankini, Y. & Y.



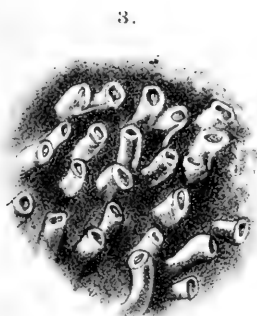




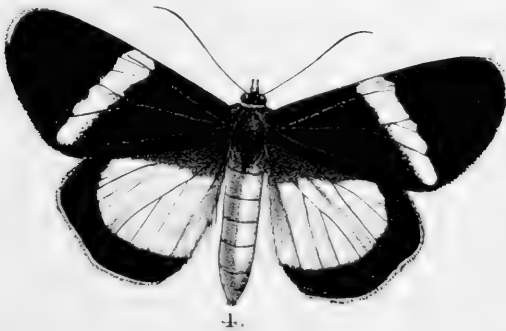




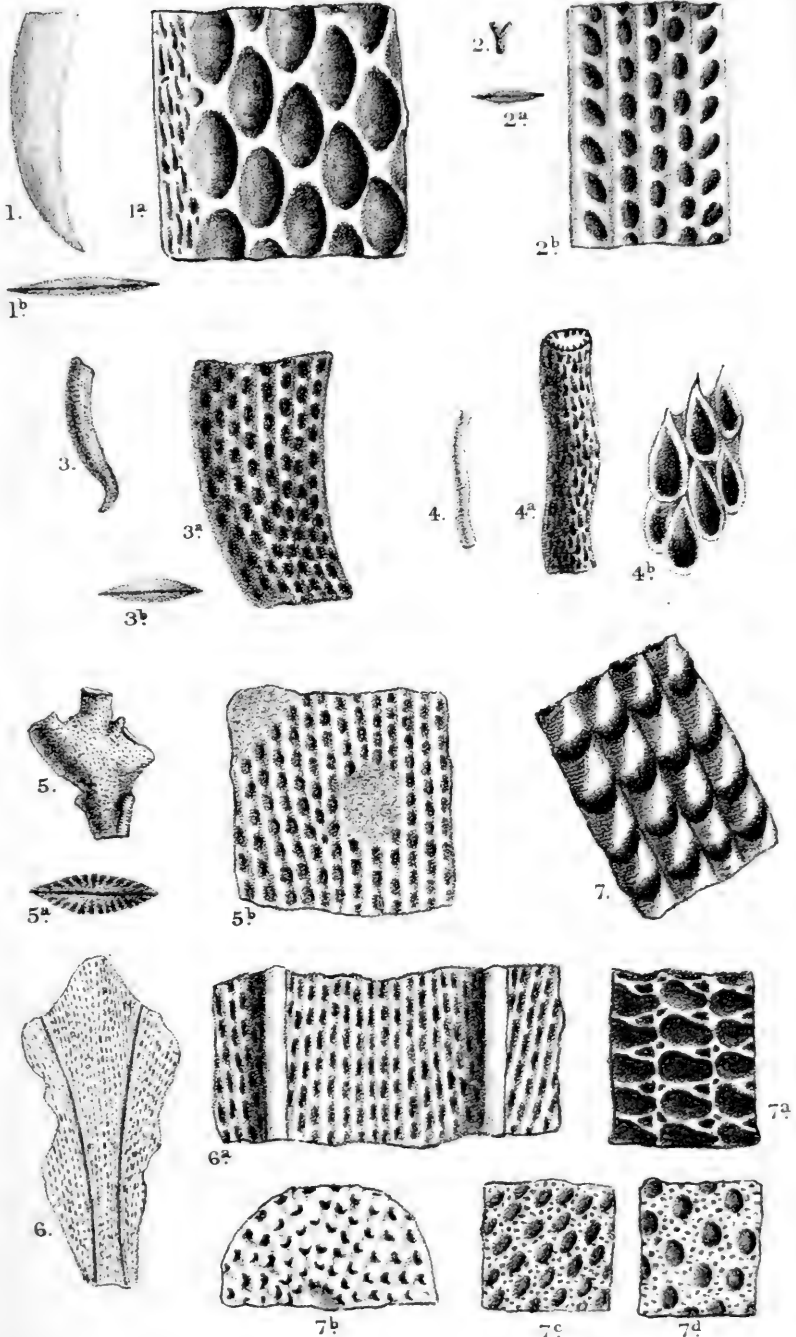
















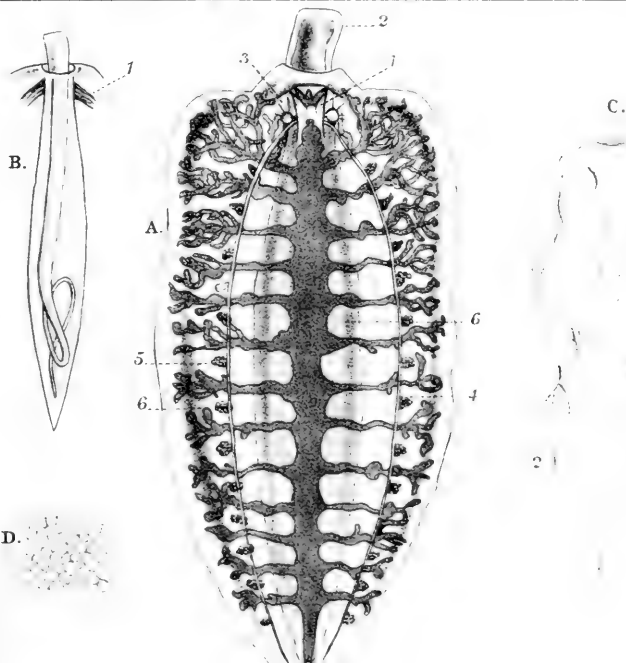
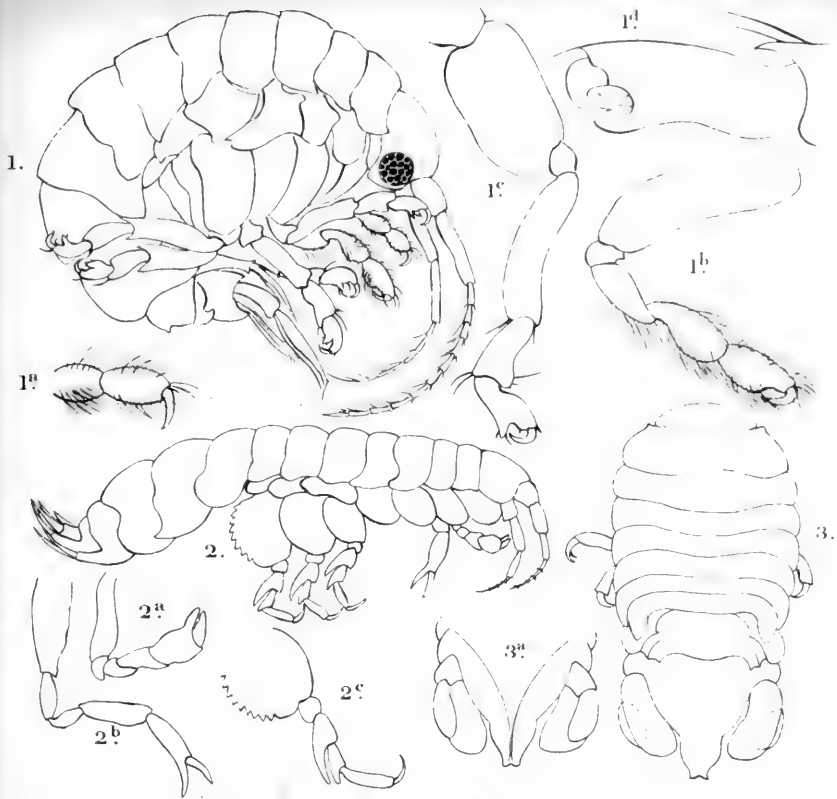




Fig. 1

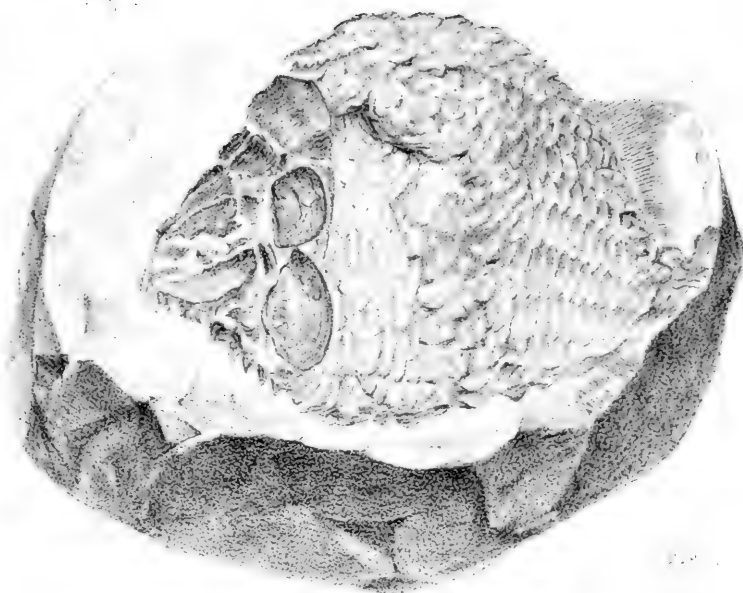


Fig. 2

Fig. 4

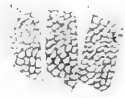


Fig. 5



Fig. 11



Fig. 6



Fig. 3

Fig. 7

Fig. 10

Fig. 8



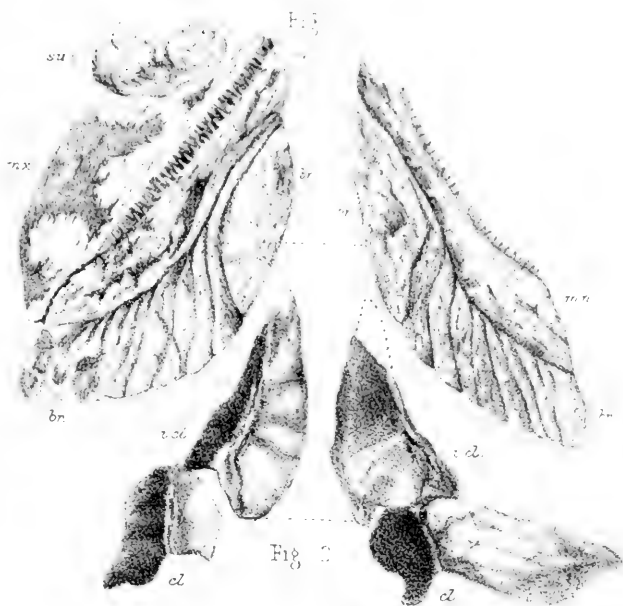


Fig. 2

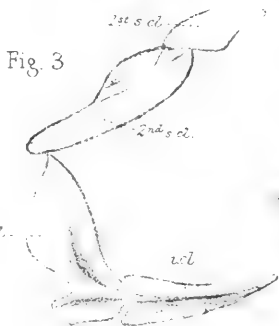


Fig. 3



Fig. 4

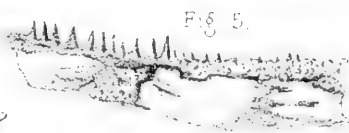


Fig. 5



Fig. 6

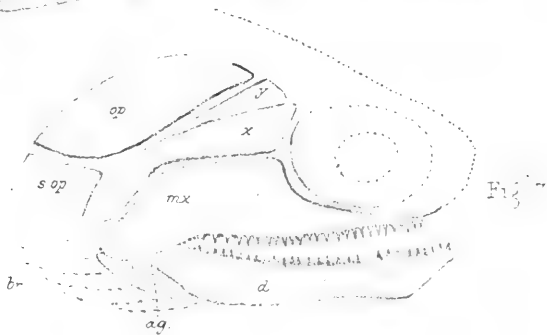
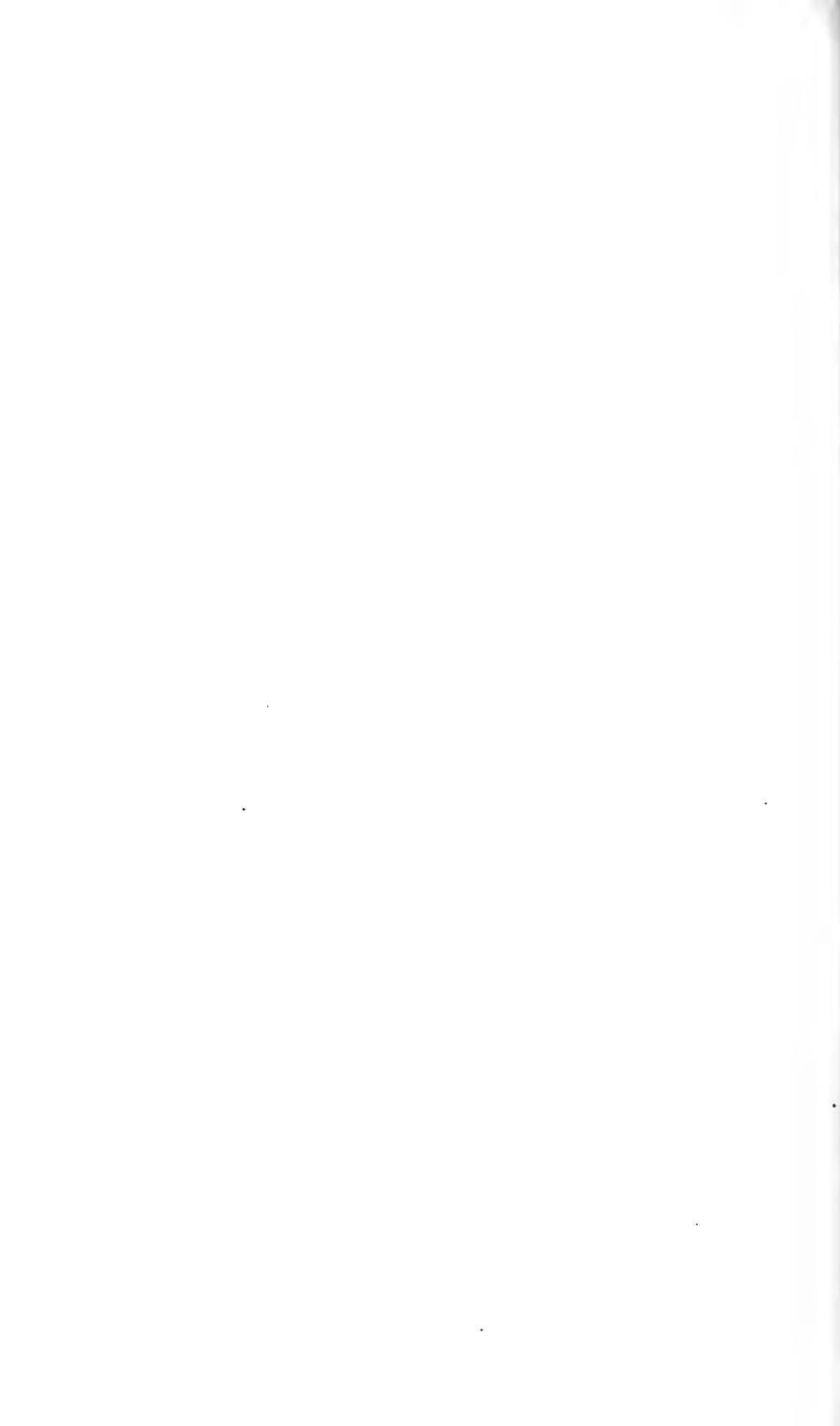
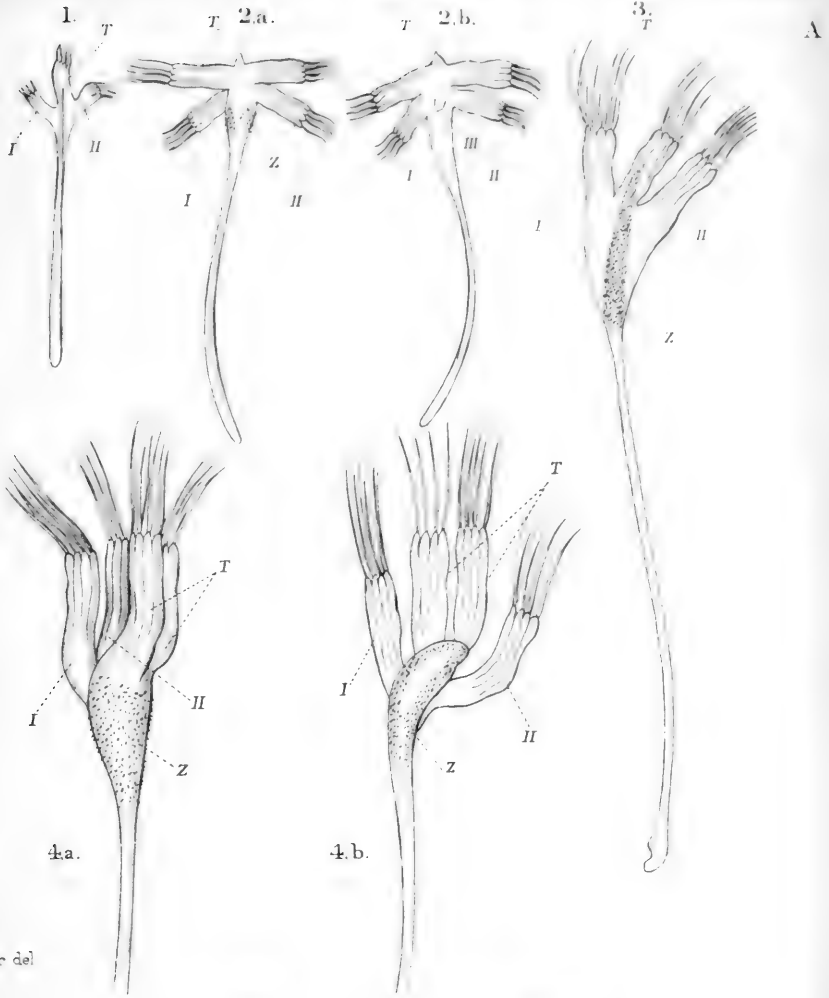
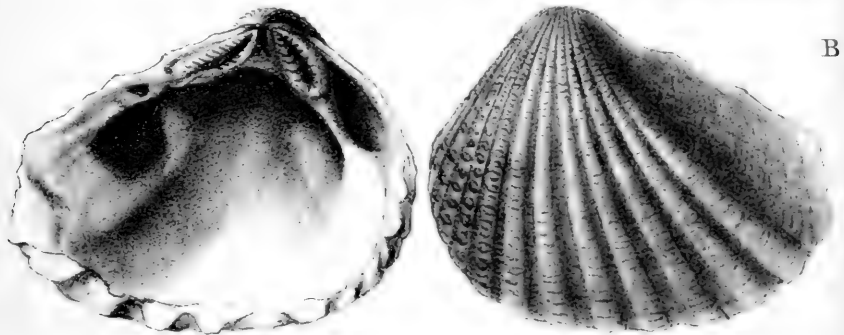


Fig. 7





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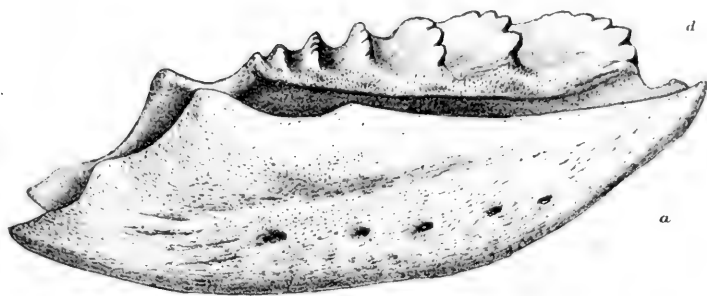
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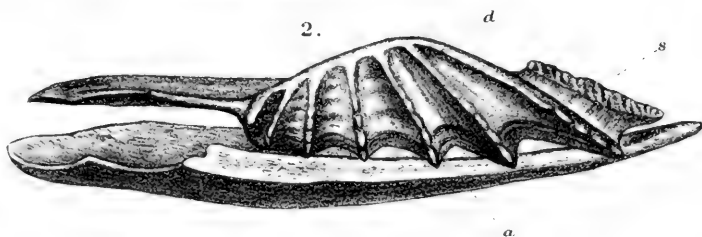




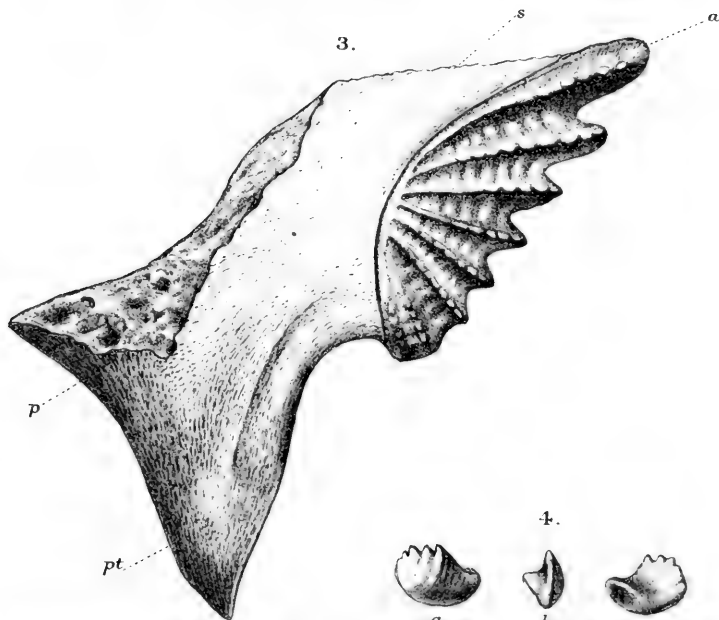
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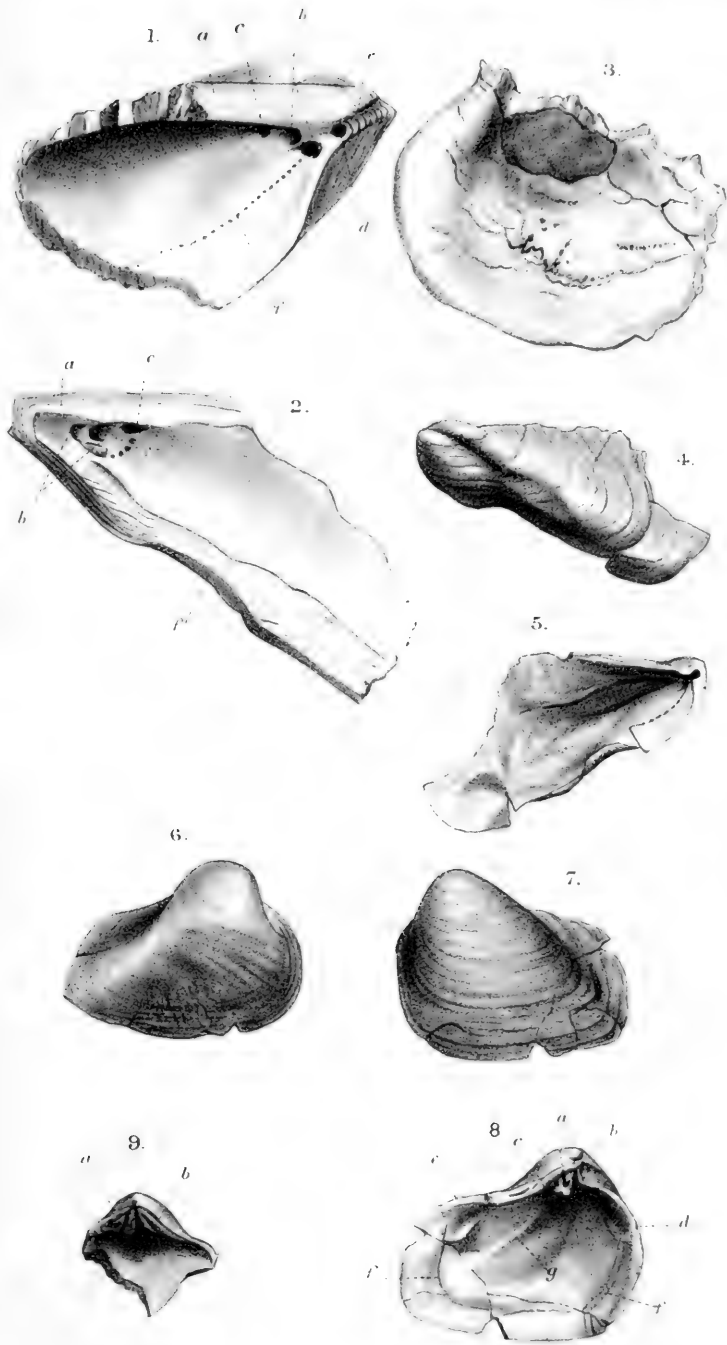
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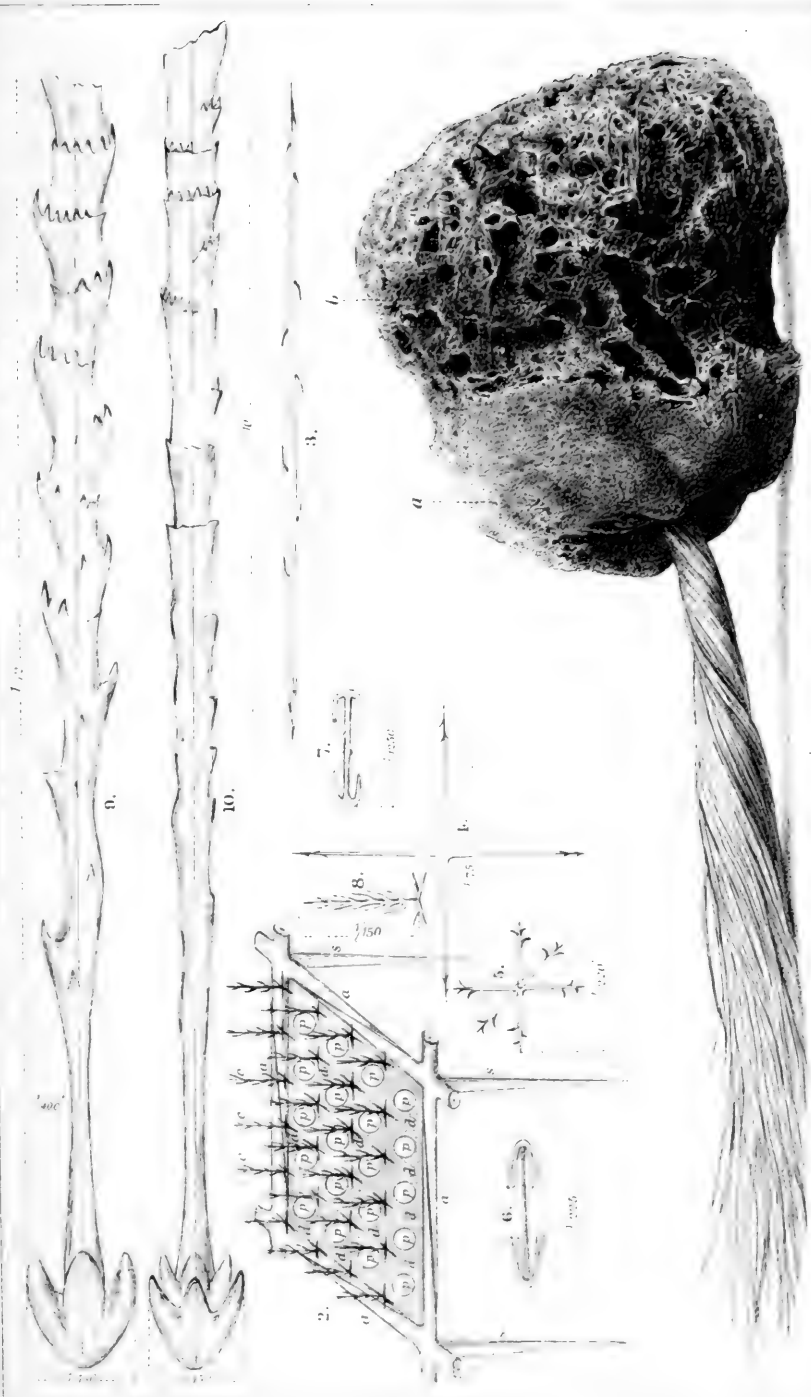
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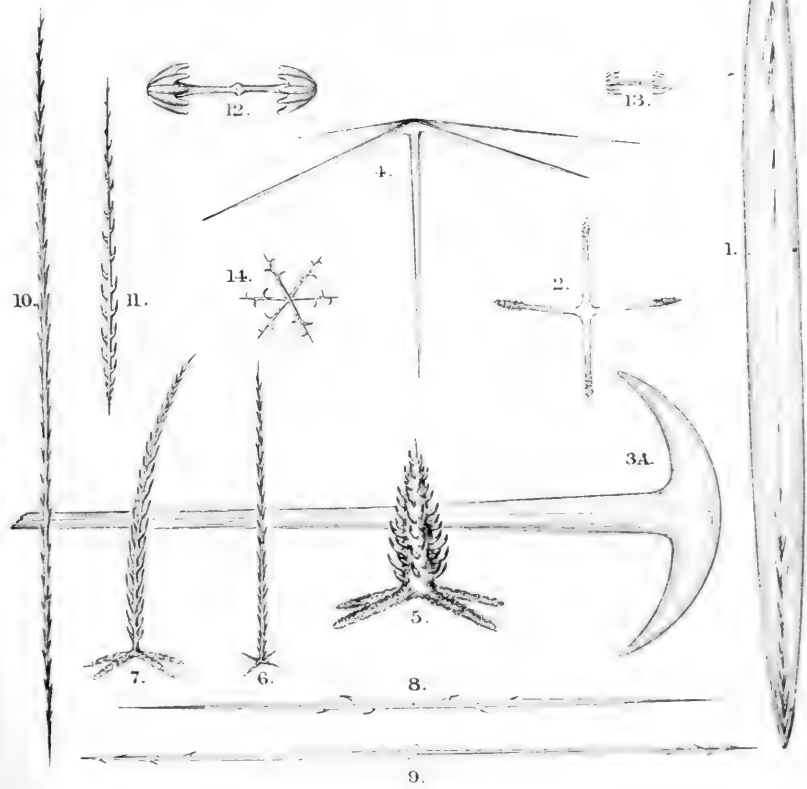








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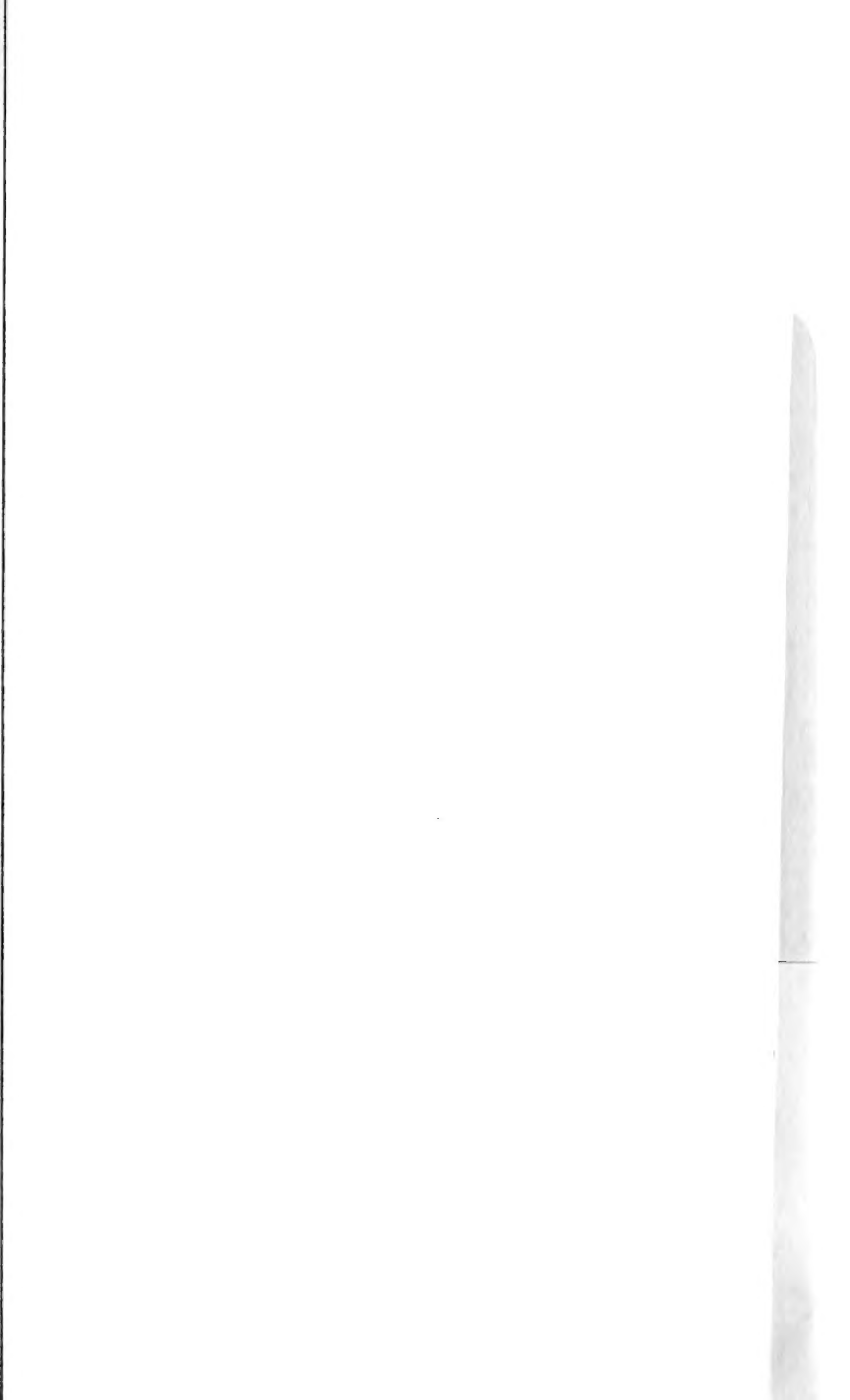
9.













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