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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1884.

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

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

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

J. TAYLOR, *Norwich*, 1818.

ALERE FLAMMAM.

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THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FIFTH SERIES.]

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

No. 79. JULY 1884.

I.—*On the* Cryptoniscidæ. By Prof. R. KOSSMANN *.

FOR the completion of my investigations upon the parasitic Isopods living upon Crustacea, the Epicaridia, the Royal Academy of Sciences granted me last autumn a considerable travelling stipend. The completion of my labour of many years has been brought into the immediate future by this liberality, for which I here with pleasure express my gratitude; but its publication will nevertheless occupy so much time that a preliminary communication of the more important results of this last journey would seem to be justified.

This journey was devoted to the investigation of the Cryptoniscidæ, and therefore of that subdivision of the Epicaridia which has been least studied, and which, on account of its extensive retrogression, presents the greatest difficulties to investigation.

In the year 1843 Rathke †, in his "Beiträge zur Fauna Norwegens," described, under the name of *Liriope pygmæa*,

* Translated by W. S. Dallas, F.L.S., from the 'Sitzungsberichte der k. preuss. Akademie der Wissenschaften,' April 24, 1884, pp. 457–473.

† Rathke, "Beiträge zur Fauna Norwegens," in Nova Acta Acad Leop. Carol. xx. p. 60, tab. i. figs. 8–12.

a minute creature which he had found in the cavity of the mantle of *Peltogaster*, which was discovered by him at the same time, a cirripede parasitic upon hermit-crabs; he regarded it as an Amphipod which had been swallowed by the *Peltogaster*.

In the same year, in an article on the sexual characters of the Cirripedia *, Goodsir published his discovery of a similar animal which occurred in *Balanus balanoides*, and which the author regarded as the male of that cirripede, the hermaphrodite nature of which was not then placed beyond doubt.

In the course of a dissertation upon *Peltogaster*, Steenstrup† found occasion to speak of *Liriope*, and indicated in a somewhat doubtful manner that it might possibly be a Bopyrid living upon *Peltogaster*.

In the same year Darwin ‡ corrected Goodsir's statement, recognizing the latter's supposed male Balanid as a parasite, and, indeed, as belonging to the "Ioniens," *i. e.* to the Bopyridæ.

About the same time (text 1852, figure 1855) Dana § described under the name of *Cryptothir minutus*, as the male, a similar parasite from *Creusia*, and referred it, with *Liriope*, to the Tanaidæ.

Lilljeborg || then (1861) came back upon this *Liriope*, and also showed that *Liriope* was an Isopod, and, indeed, a Bopyrid. He succeeded particularly in this, that besides the larviform and excessively minute creatures that Rathke and Dana had found, he also discovered the mature female form of *Liriope*, and he came to the conclusion that the former were the young males.

Buchholz¶ arrived at a somewhat different conclusion in some respects. Without knowledge of the statements of Goodsir and Darwin, he carefully described anatomically the animal observed by them. He regards the forms found by himself, so far as they look like *Liriope*, as older larvæ, and

* Goodsir, "On the Sexes, Organs of Reproduction, and Mode of Development of the Cirripeds," in Edinb. New Phil. Journ. xxxv. p. 88, pls. iii. and iv.

† Steenstrup, "Bemärkninger om slaegterne *Pachybdella* og *Peltogaster*," in Oversigt af Danske Vidensk. Selsk. Forhandl. 1854.

‡ Darwin, 'Monograph on the Subclass Cirripedia' (Ray Society), vol. ii. p. 271.

§ Dana, 'Crustacea in U. S. Exploring Expedition under Commander Wilkes,' vol. ii. p. 801, Atlas, pl. liii. fig. 6.

|| Lilljeborg, "*Liriope* et *Peltogaster*," in Nova Acta Soc. Sci. Upsal. ser. 3, vol. iii. p. 1, and Suppl. p. 73 (see 'Annals,' ser. 3, vol. vii. p. 47).

¶ Buchholz, "Ueber *Hemioniscus balani*," in Zeitschr. für wiss. Zool. Bd. xvi. p. 303.

the male as still unknown. Nevertheless he was the first to give us an idea of the adult parasite, as Goodsir had only figured the head and the first four thoracic segments, but neglected all the remaining deformed part of the animal.

A further enlargement of our knowledge upon this group was furnished in the year 1871 by a memoir of Fritz Müller's*. Under the name of *Cryptoniscus planarioides* he described a parasite resembling *Liriope*, but which displaces its host, a *Peltogaster*, from the hermit-crab; only the roots of the *Peltogaster* are preserved, and are apparently made use of by the *Cryptoniscus* for its own nourishment.

Soon after the appearance of Müller's memoir, and without any acquaintance therewith, I myself published notes † upon some forms belonging to this group from Semper's Philippine collections, namely an internal parasite from *Sacculina pisiformis*, which I named *Eumetor liriopides*, an external parasite on the abdomen of a *Porcellana* (*Zeuxo porcellanæ*); another on the head of an *Alpheus* (*Zeuxo alphei*); and, lastly, a parasite from the brood-cavity of a *Bopyrus* (*Cabira lernæodiscoides*). Any exact anatomical investigation of these forms was impossible, as I had only single spirit-specimens of them.

Passing over Hesse's unscientific and useless memoirs in the 'Annales des Sciences Naturelles,' I come to the most recent and important work upon this subject, namely Fraisse's memoir "Die Gattung *Cryptoniscus*, Fr. Müller" ‡. To its contents I shall have to refer repeatedly.

There has long, as we have seen, been a general conviction of a near relationship between the Bopyridæ and Cryptoniscidæ. When, therefore, I formed the plan of undertaking a monographic description of the Bopyridæ, I could not think of passing over the Cryptoniscidæ. Moreover, there were points of difference between the statements of Buchholz and Fraisse and the results of my own occasional investigations, which made a thorough testing of the investigations of these two meritorious observers appear indispensable.

I have therefore twice, in 1882 and 1883, thoroughly studied *Hemioniscus balani* in Christiansand itself, and in the autumn of 1883, with the aid of the Royal Academy which

* Fritz Müller, "Bruchstücke zur Naturgeschichte der Bopyriden," in Jenaische Zeitschrift für Medicin und Naturwissenschaft, Bd. vi. p. 61, Taf. iv. figs. 12–19.

† Kossmann, "Beiträge zur Anatomie der schmarotzenden Rankenfüssler, Anhang," in Arbeiten aus dem zool.-zootom. Institut der Univ. Würzburg, Bd. i.

‡ Arbeiten aus dem zool.-zootom. Inst. der Univ. Würzburg, Bd. iv.

has been already gratefully mentioned, *Cryptoniscus paguri* at Mahon, in the island of Minorca; at other opportunities I have also examined single specimens of nearly all the forms pertaining here. Upon these investigations the following brief expositions are founded.

But before I enter upon the actual subject, a formal necessity presses itself upon me. As in my monograph I must, of course, employ a critically sifted and correctly established nomenclature, and yet must not lay too great difficulties in the way between the preliminary and the detailed work, I think I ought here to give a small table relating to this matter.

I. Parasites on Cirripedes.

a. Upon non-parasitic Cirripedes (*Balanus balanoides* and *Creusia*).

1. Cryptothir, Dana, 1852 (U. S. Expl. Exped., Crustacea, p. 801).
Synonymy:—*Hemioniscus*, Buchholz, 1866.
Cryptothiria (p. parte), Spence Bate & Westwood, 1868.

b. Upon parasitic Cirripedes.
α. Free in the mantle-cavity.

2. Eumetor, Kossmann, 1872 (Beitr. z. Anat. d. schmar. Rankenfüssler, Anhang).

β. Perforating the mantle from within.

3. Liriopsis, Max Schultze, 1859 ("Anm. zu einer Aufsatz von Fritz Müller," in Wiegmann's Archiv, Bd. xxv. p. 310).
Synonymy:—*Liriope*, Rathke, 1843, nom. præoccup. (Lesson, 1837, Trachymedusæ).
(This form is referred by F. Müller and Fraisse to *Cryptoniscus*, by Spence Bate to *Cryptothiria*).

γ. Attacking the peduncle from without, and displacing the cirripede down to the roots.
aa. Upon *Peltogaster*, with short cephalon.

4. Cryptoniscus, Fritz Müller, 1870 (Jena. Zeitschr. Bd. vi. p. 61).

ββ. Upon *Sacculina*, with long cephalon penetrating deeply into the Brachyuran.

5. Zeuxo, Kossmann, 1872 (Beiträge z. Anat. d. schm. Rankenf.), nom. præoccup. by Templeton, but suppressed by Dana in favour of *Tanaïs*.

II. Parasitic on Ostracoda.

6. Cyproniscus, Kossmann, gen. nov. Referred by Sars ("Oversigt af Norges Crustaceer," in Christ. Vidensk. Selsk. Forhandl. 1882, no. 18, p. 73) to *Cryptothiria*.

III. Parasitic on Isopoda.

7. Cabirops, Kossmann, gen. nov.
Synonym:—*Cabira*, Kossmann, 1872 (Beiträge &c., Anhang), nom. præoccup. (Treitschke, 1825 *Cabera*, Jodoffsky, 1837 *Cabira*, Lepidoptera).
Referred by Sars (Oversigt &c. p. 74) to *Cryptothiria*.

What from the first caused the greatest difficulty was the ascertainment of the sexual relations. The form first described by Rathke with eyes and natatory feet has been interpreted sometimes as the male, sometimes as the larva. Rathke himself evidently regarded his animal as adult, but without deciding any thing as to its sex. Dana took the corresponding form, which he found in *Creusia*, for a male, but made no remark about its age. Lilljeborg's discovery proved that the animals described by Rathke and Dana were young forms; and it seemed to Lilljeborg impossible to regard them as young female forms, because, although already settled upon the host, they showed no commencement of the transformation into the adherent female form. He further compared them with the youngest male Bopyrides found by Kröyer, and came to the conclusion that they were immature males. Buchholz regarded this same form (from *Balanus balanoïdes*) as an old larva without recognizable sex; he found no males, but at the same time declared that the sexually mature animals (*Cryptothir balani*) found by him were decidedly not hermaphrodite. Spence Bate, who had already seen and named the young animal *, thought, in 1868 †, it might perhaps be a male, and adds to the word "immature" a note of interrogation within brackets. He therefore doubted as to the immaturity of the animal, but without in any way proving that it was a male, still less a mature one.

Lastly, Fraisse ‡ asserts with almost perfect certainty that the copulation must take place "in the stage preceding attachment," and accordingly describes both male and female animals of this stage (representing Rathke's *Liriope*), of which, however, he regards only the former as sexually mature. But his proof would not satisfy most readers. Thus, as regards the males, the testes are scarcely indicated in Fraisse's figure; their form, aperture, or even structure he has not described at all; the semen, which was squeezed out by crushing the animal, is not removed beyond the reach of doubt, on account of the mode in which it was obtained and the statements as to the form of its elements, and indeed it is rendered absolutely suspicious by the fact that Fraisse supposed he saw it also in the body-cavity of the female attached to the ovaries, where its presence may be pronounced to be impossible. Fraisse found these supposed males swimming

* Spence Bate, 'Report of the British Association,' 1860, p. 225.

† Spence Bate and Westwood, 'History of the British Sessile-eyed Crustacea,' vol. ii. p. 267.

‡ Fraisse, "Die Gattung *Cryptoniscus*," *loc. cit.* p. 23, Taf. xv. figs. 30 and 32.

freely; but he observed exactly similar animals creeping or swimming about close to the *Sacculina*, and these he regarded as females. He saw no genital apertures, or, indeed, genital organs of any kind in them, but observed their conversion into the adherent animal, which undoubtedly is of the female sex. As, however, in this, in a stage which is already strongly metamorphosed, the ovaries are still quite immature, the female larva, according to Fraisse's own opinion, can only be quite immature. Nevertheless, although he had "no opportunity" of observing the copulation, and did not even himself see "the spermatophores adhering to the female," he is of opinion that this immature larviform female must already be fecundated. "Thus, therefore," he writes, "the fecundated female attaches herself, while the male retains its form and probably perishes after the act of copulation."

Evidently all that he has seen (or not seen) is opposed to Fraisse's own opinion, and tends to show that the male is indeed sexually mature and copulates in the above-mentioned larviform stage, but that the female becoming sexually mature at a much more advanced stage is also sought out and impregnated by the male only in this sessile condition.

That the male is really larviform I can positively assert from careful examination of such stages. We can very distinctly recognize the genital apertures at the base of the last pair of pereiopoda; we find the mature testes in the transverse section, and witness the brisk movement of the spermatozoids. *In the Cryptoniscidæ, therefore, the mature male is larviform and still furnished with natatory feet upon the pleon.*

That the female is coupled before its sexual maturity there are no observations to show, and nothing warrants any such supposition. But that on arriving at sexual maturity it is sought out and copulated by the male is supported by the observation of Buchholz, who writes with regard to *Cryptothir* (*Hemioniscus*) :—"Nearly in every *Balanus* which contained one of the sacceiform animals there occurred one or more small, elongated, brownish animalcules" (here follows the description of Rathke's *Liriope*-form) ; as also by Fraisse's own figure (Taf. xii. fig. 1), in which such a larva is shown clinging to the metamorphosed female; and, finally, by the fact that, in 1872, I found such a male animal, as I then supposed, in the Philippine *Eumetor liriopides*, and in 1883 in a Neapolitan species of the same genus, three of them, and, indeed, clinging fast to the female. The natatory power of these males makes it very easy to understand that we do not always meet with them with the females as among the Bopyridæ; they probably often spontaneously quit the female, and are certainly still more frequently missed by the observer. In short I accept it as proved *that the female is copulated only in the metamorphosed state.*

We have therefore free-swimming larviform males, and adherent, strongly retrograded females, which copulate with each other. But this is not all. My investigations furnish the most convincing indications that the two forms are only different stages of development of the same individual; in other words, that among the Cryptoniscidæ we have to do with a *protandrous hermaphrodism.* According to the investigations of Bullar and Paul Mayer such a thing is not unprecedented among Isopoda, but rather undoubtedly recognized among Cymothoidæ; there, however, the sexual maturity of the male occurs much later, after the biramose natatory feet upon the pleon, characteristic of the larva, have already become transformed into branchial feet. Protandry with larval sexual maturity was previously entirely unknown.

Of course it has not been possible for me to trace one and the same individual through its whole course of development; to observe how, as male, it performed the duties of its sex, and how, after the metamorphosis had taken place, it was copulated as a female, and produced eggs. I can therefore, as already stated, only bring forward evidence in favour of my assertions.

First of all negative:—I have never found a free-swimming Cryptoniscid larva of the last stage that had not male-developed sexual glands. I have found and examined of *Cryptothir balani* a considerable number, and of *Eumetor* three—all males. Fraisse, indeed, describes female larvæ, but these were already fixed, and not truly female, but immature, neuter; the free-swimming examples of which he found some, were males. It is clear that the protandry is proved, unless we succeed in discovering females or neuters in the same stage of development as the males, hitherto exclusively found.

A second piece of negative evidence is the following:—While in all Bopyridæ s. str., and in the Entoniscidæ the male becomes sedentary and remains with the female, it is in all Cryptoniscidæ free-swimming and exceedingly active, and is often no longer to be met with near the fecundated female. How should this difference between two so nearly related groups be explicable if the male had not still another task to fulfil elsewhere after the fecundation of the female? and what other can it be except that of itself growing into a female upon another host?

Finally, we have a piece of positive evidence in the presence in the mature female of a gland which is to be regarded almost with absolute certainty as a retrograded testis. This gland was discovered by Buchholz* in *Cryptothir balani*, but is wanting in none of the Cryptoniscidæ examined by me, while no female Bopyrid or Entoniscid possesses even the smallest trace of it. Buchholz thought that this gland was to be regarded as an accessory organ of the sexual parts; notwithstanding repeated endeavours he could discover no efferent duct, but he found the granulated contents to be like those of the terminal section of the female genital duct. His figure and description represent the organ as a thin cord inflated in three places, situated on three sides above and outside of the ovaries, and filled with a finely granular substance. The inflated parts form cellular diverticula.

Now this organ extends through the last three segments of the pereion, therefore the same in which the testis is situated in the male. These three segments of the larva are widely separated immediately before the last change of skin, and afterwards enormously enlarged by colossal reception of nutriment. At the same time, however, the triple division continues recognizable by transverse constrictions. If therefore a testis no longer in function be present, what is more natural than that this should retain its original thickness in the three segments, but become stretched into a thin cord in the intervals—in short, acquire the form represented by Buchholz? and is not also the deficiency of the efferent duct, ascertained by me, in favour of the view that we have to do with an organ no longer in function? Lastly, as regards the contents. In my transverse sections these appear as a finely granular, strongly refractive, and very strongly colouring detritus, which in these three properties is absolutely similar to the contents of the testes in the males of the Bopyridæ (provided there is no semen in them).

From all this we may regard it as almost proved to demonstration that the Cryptoniscidæ are really protandrous hermaphrodites, in which the testis attains its maturity in the final larval stage, and is then visible in the mature female as a rudimentary organ without an efferent duct.

The question now arises, what circumstances have operated for the production of this kind of hermaphrodism, seeing that the Bopyridæ, which are so nearly allied, are certainly not hermaphrodites?

We generally find hermaphrodism especially in slow-moving or adherent animals, and to these it gives an essential advantage in the struggle for existence. In the first place, it renders

* Buchholz, *loc. cit.* p. 316, Taf. xvi. figs. 2 & 3, G.

self-fertilization possible in cases where a meeting of two individuals can occur only with difficulty or not at all. Now self-fertilization is certainly in other respects injurious; as intensified incestuous breeding it has an exceedingly corrupting influence upon the organization of the race. It is no doubt for this reason that in some hermaphrodite groups of animals the habit of mutual fecundation has been brought about. In this certainly the above-mentioned advantage disappears; the contact of two individuals is, as in other cases, necessary. On the other hand, another advantage results from it, namely, when the comparatively obstructed chance of contact does occur, then at least two individuals are fecundated, and consequently there exists twice as much probability of the preservation of the species as if the animals were not hermaphrodite.

But if in this way hermaphrodism with mutual fecundation may in certain species replace that with self-fertilization with favourable results, this applies only to such as move with difficulty and not to sedentary species. In the latter, contact, and consequently mutual fertilization, is impossible. Here therefore we must rest satisfied with self-fertilization, if the animal were really sedentary during its whole existence. But this is the case in no animal proceeding from an egg; and all animals proceed from an egg, if not in every generation, nevertheless in generations recurring regularly after a certain time.

From this it follows that even in animals which become sessile contact may take place, always supposing that one of the two individuals is not yet sessile. During this contact they might fertilize each other, if both kinds of sexual organs were already developed in both. This, however, for economical reasons is usually impossible; for parasites, at least, it is attachment that usually secures that quantity of nutriment which is necessary for the egg-production; and, on the other hand, parasites generally require for the maintenance of their species such a colossal fertility, that the egg-formation of itself deforms the body and compels it to become attached. Hence, with special exceptions, it is not well possible that the free-moving individual should already possess ovaries; consequently neither a mutual fertilization nor the one-sided one supposed by Fraisse can be accepted as taking place between two free-swimming animals. On the other hand, the animal may well be capable of the production of the semen, of which no great quantity is necessary, even before the commencement of adhesion, and thus the protandry above described would be brought about. An advantage over the simple dimorphism of the sexes is, however, also obtained. If I assume (quite arbitrarily) that the individual occupies a week from hatching to male maturity, and then three weeks from hatching to female maturity, then to obtain 10 (or n) broods in the case of dimorphism, 10 (or n) individuals must escape all the dangers that threaten them each for a week, and 10 (or n) individuals each for three weeks (40 or $4n$ weeks), while in the case of protandry only 10 (or n) individuals need to exist each for three weeks and 1 more for one week ($=31$ or $3n+1$ weeks). And the advantage is even still greater than these numbers show, as it is precisely the first week in which the animal (in our case) swims freely about, and consequently is much more exposed to dangers than during the next two weeks, when it is already adherent. Those 9 (or $n-1$) weeks which in our example are saved by protandry are, as one may easily convince one's self, all first weeks of life. It is the first week, that of the free-swimming stage, of nine female individuals that is saved.

The notions as to the nature of the brood-cavity in which the ova in the Cryptoniscidæ are sheltered until hatching have hitherto been very defective. Buchholz* found that in *Cryptothir balani* the deposited eggs "float to and fro . . . apparently free in the body-cavity;" but in reality are "enclosed in a special, extremely delicate-walled, and perfectly transparent vesicle." His further statements upon this subject do not seem to me very clear. He finds this vesicle attached to the outer wall of the body at the spot "at which the four genital apertures are situated. . . . . If we separate the pedicle of the vesicle from this spot we obtain it in connexion with the four oviducts, which remain attached to it uninjured, and the outer extremities of which seem to pass directly into the vesicle." Thus, while Buchholz originally saw the oviducts open outwards, he sees them afterwards open into the vesicle; both observations which I can confirm as correct. In spite of this the original four sexual apertures are said to persist on the outer surface. "Nevertheless," he says, "the presence of external sexual apertures at this spot, simultaneously with the opening of the oviducts into the egg-reservoir, is difficult to understand." In my opinion, it is not to be understood; and his attempted explanation, which I shall not reprint here, is quite unintelligible to me. The true condition of things in *Cryptothir*, as I have observed with certainty, is, that there is a sinking in of the region of the genital apertures, at first in the form of a transverse groove. In this way

* Buchholz, *loc. cit.* p. 315.

a brood-space with a transverse entrance-fissure is formed by invagination, and as its inner surface is the former surface of the animal in the neighbourhood of the oviducal aperture, the oviducts of course no longer open outwards, but into this newly-formed brood-space.

Somewhat more complicated, but perhaps more primitive, is the arrangement in the other Cryptoniscidæ, at least in *Cryptoniscus* and *Liriopsis*. Fraisse* falls into an error, which, however, his predecessor had escaped; he says, "This brood-cavity was previously present, for it is simply the body-cavity," and adds, "How the ova get into it I cannot say;" and, in fact, it would be hardly possible to establish a conceivable hypothesis upon this view: deposition of the ova in the body-cavity would be something unheard of among Crustacea. Into this brood- or, according to Fraisse, body-cavity lead two "respiratory" apertures, already very fully described by him, one of them in the neighbourhood of the mouth, the other further back, and the two united with each other by a longitudinal groove (upon the ventral surface). Of this groove Fraisse says (p. 13):—"When the larvæ are ready for a free existence, a fissure bursts which formed between the two respiratory apertures during the third stage, and was previously covered and closed by a thin cuticular layer." Through this the larvæ are set free.

The actual course of events, as I have ascertained by the study of numerous transversely-sectioned specimens, is as follows. Here also, first of all, the two oviducts (which Fraisse, *l. c.* p. 9, was unable to detect) open on the ventral outer surface of the body. Their originally circular aperture becomes elliptical and is soon drawn out before and behind into a shallow groove, so that we may easily recognize two such parallel longitudinal grooves in the female when not yet quite mature. Now the wall between the two grooves begins to sink in, and thus we obtain, instead of the two shallow grooves, an elongated depression, the two side walls of which curve into one another before and behind. These side-margins now, however, grow towards one another until they touch throughout nearly their whole length; there remains consequently only a hair-like slit, which passes at its posterior and anterior ends into a rounded hole, and these two holes lead into a cavity formed by the sinking in of the wall lying between the two genital furrows. This cavity, into which of course the oviducts open, is the brood-cavity, but it has absolutely nothing to do with the body-cavity. It becomes filled

* Fraisse, *loc. cit.* p. 12.

with deposited ova and thereby enlarges in proportion as the ovaries (and at the same time also the alimentary organ) diminish in volume.

That the ova obtain the change of water necessary for respiration, is provided for by brisk pumping movements, which, as Fraisse correctly describes, are effected in this later stage by the musculature at the two brood-space or respiratory apertures; and that the current of water shall not wash out the ova, by a system of villiform valves which close the apertures eelpot fashion, as Fraisse has also shown. This whole arrangement is produced, moreover, before the last moult of the animal, and therefore, in a certain stage, the fissure of the brood-chamber still appears, as Fraisse says, "covered and closed by a thin cuticular layer." Subsequently, however, the fissure still holds together, only because the two margins are to a certain extent interlocked; with a little effort they can be readily forced asunder without tearing anything. But spontaneously the fissure certainly only opens when the brood-cavity is overfilled, and the parent animal performs the most violent contractions. As Fraisse correctly describes, these often still continue when all the ova are already expelled; and as, at this time, the ovary and alimentary apparatus, the only coloured organs of the animal, are completely retrograded, the animal, which now resembles a torn and perfectly transparent rag, and yet contracts violently, presents a very remarkable appearance.

Passing over many details of less general interest I cannot abstain from stating something with regard to the mode of taking nourishment and the alimentary organs.

In *Cryptothir* (*Hemioniscus*), as Buchholz has already shown, the cephalon and the pereion as far as the antepenultimate segment remain larviform throughout life; in accordance with this the small boring and sucking apparatus, consisting of the labrum and labium, between which two styliform mandibles are placed, serves through life as the organ for the inception of nourishment. This anterior division of the body is, however, also deformed in the other genera. The genus *Zeuxo*, which I discovered in 1872, lives upon parasitic Cirripedes, especially upon *Sacculina,* a parasite of the Brachyura. It perforates this animal, the pedicle of which ramifies like a root in the body of a common crab, at the point where the pedicle enters into the body of the crab, and draws nourishment from it, after the fashion of a plant; it consequently intercepts the nourishment of the *Sacculina,* and often causes it to die away altogether with only the exception of the roots. These roots, singularly enough, remain alive, and are made use of by the *Zeuxo*. The head of the latter, which is finally inserted deeply into the body of the crab, although always still in a great lacuna of the radiciform pedicle of the *Sacculina*, presents, besides the buccal aperture, only four cylindrical processes, of which one pair is usually longer than the other. By their form and position they give rise to the supposition that they are the antennæ of the larva which have lost their articulations. They evidently effect the fixation of the animal. In some species the fore part of the body, from the place where it enters into the body of the host to the mouth, is drawn out into a long peduncle; in others it is rather short.

Upon another parasitic Cirripede (*Peltogaster*) lives the genus *Cryptoniscus*, F. Müller, under exactly similar vital conditions. Its head does not form a peduncle, but within the aperture which it has perforated we find four pad-like swellings surrounding the mouth, which, from analogy, we may also regard as modified antennæ. That this genus almost always brings about the destruction of the *Peltogaster* itself has been already indicated by Fritz Müller and confirmed by Fraisse; now and then, indeed, we find a specimen which seems not to be seated directly upon the hermit-crab, but has bored somewhere into the mantle of the *Peltogaster*; but if such stray examples, on the one hand, do not quite cause the destruction of the *Peltogaster*, on the other hand they do not seem themselves to arrive at female sexual maturity.

It is otherwise with the genus *Liriopsis*, Max Schultze (*Liriope*, Rathke), which also lives upon a *Peltogaster*. This animal (the anterior and posterior ends of which have been hitherto mistaken) does not perforate the pedicle of the *Peltogaster*, but slips into the cavity of its mantle, and perforates the mantle from within. Thus the anterior half of the body is inserted into the blood-lacunæ of the mantle, while the posterior half lies free in the mantle-cavity, and the perforation which the parasite has made causes a median constriction of the animal. But in this case, not only the head, but at least five segments of the middle-body are inserted into the host; and as the aperture through which the brood of the *Liriope* swarms out is formed upon these segments, the parasite, when the brood is mature, or perhaps a little earlier, must also break through the outer wall of the mantle. This is probably effected less by boring than because its own growth exerts such a pressure upon the tissues before it that the latter become atrophied and finally burst. The parasite then remains with the abdomen in the mantle-cavity and the fore part of the body outside in the open. I have been unable any longer to detect antennæ or buccal organs in the stage of female maturity, and my experience was similar in some other genera. Among these are *Eumetor*, which was likewise discovered by me in 1872, and has now been more accurately studied, and *Cabirops*, which inhabits the brood-cavity of the Bopyridæ, its nearest allies. All these three genera, in the adult condition, have the head free, and consequently need then no apparatus for fixation or boring. It is true also that they can then take no more nourishment. But this is no longer necessary to them; *Cryptoniscus* and *Zeuxo* also at this time take no more nourishment, although they have the head still inserted into the blood of the host. This follows with certainty from the retrogression of the digestive apparatus, already ascertained by Fraisse in *Cryptoniscus*.

The knowledge of the nature of this digestive apparatus has advanced by various roundabout ways; I will here only briefly refer to its course hitherto. Rathke* ascribed to the Bopyridæ a liver consisting of seven pairs of follicles opening separately into the intestine; Cornalia and Panceri†, certainly in a different genus, describe, instead of these fourteen follicles, two tubes running parallel to the intestine, their opening into which they did not see. Buchholz‡ found in *Cryptoniscus balani*, intercalated between the œsophagus and the rectum, a comparatively enormous vesicular reservoir, drawn out posteriorly into two cæca, which, from its appearance, is "really to be regarded as the intestinal canal;" and a similar condition of things in *Entoniscus* was described first by Fritz Müller § and afterwards by Fraisse ||, the former characterizing the organ as the liver, the latter as rectum. This latter interpretation, as a section of the intestine, is also maintained by Fraisse for a corresponding organ in the Cryptoniscidæ, which certainly, by its exceedingly vigorous growth, soon loses all trace of a division into parallel tubes. I have already elsewhere, with regard to the Bopyridæ and Entoniscidæ, adopted the opinion of those who regard this organ as a homologue of the so-called liver of the Crustacea. I do so also unconditionally with respect to the digestive organ of the Crypto-

* Rathke, 'De Bopyro et Nereide,' 1837, p. 9, tab. i. fig. 7 *b*.

† Cornalia e Panceri, "Osservazioni sopra un nuovo genere di crostacei isopodi sedentarii, *Gyge branchialis*," 1858, p. 16, tab. ii. fig. 6*e*.

‡ Buchholz, *Hemioniscus balani*, loc. cit. p. 310.

§ Fritz Müller, *Entoniscus porcellanæ*, in Archiv für Naturg. Bd. xxviii. p. 11.

|| Fraisse, *Entoniscus Cavolinii*, 1878, p. 17

niscidæ. Both the development of the organ from a pair of cylindrical cæcal tubes opening into the anterior part of the intestine and its histological nature prove the homology with the so-called liver. But just as I have already said with regard to the Bopyridæ that this so-called liver does not function exclusively as such, but evidently performs "a function as a section of the intestine," so must I also assert decidedly that the lumen of this so-called liver receives the food of the parasite, which is identical with the blood of the host, in immense quantities; that in this place this nutriment is digested and absorbed, during which the organ gradually shrivels up; and that consequently the name of liver is by no means physiologically applicable to the organ. But at the same time it has been sufficiently demonstrated that the so-called Crustacean liver is no liver at all. The name reposes on an error called forth by the most insignificant superficial character, namely the colour of the organ. Hoppe-Seyler * and Krukenberg † found in the secretion of the so-called liver of the higher Crustacea a diastatic, a peptic, a tryptic, and a fat-decomposing enzyma. Max Weber ‡ believed that he found in the epithelium of the liver, besides the true hepatic cells, a second kind of cells, which he supposed to fill the above more pancreatic function, and he named the organ *hepatopancreas*. But Hoppe-Seyler showed in the freshwater crayfish, and Frenzel § has lately done so in many marine Crustaceans, that no biliary constituents at all are present in the secretion. There are no biliary acids or their soda and potash salts, no bilifuscin or the allied pigments; and bilirubin was sought in vain. To this must be added that Frenzel has also ascertained that Weber's assertion that there are two different kinds of epithelial cells is erroneous. In my Epicaridia nothing of the kind can have existed. In short this organ, wherever it has the form of a gland, is clearly the digestive gland of the Crustaceans, a *glandula intestinalis*. But in the Epicaridia, and especially in the Cryptoniscidæ, the lumen of the intestine does not suffice for the reception of the food, and then this organ takes part in it in a very remarkable manner. Thus from a *glandula intestinalis* it becomes an *intestinum glandulare*, a reservoir,

* Hoppe-Seyler, 'Physiologische Chemie,' p. 276.

† Krukenberg, "Vergleich.-physiol. Beitr. zur Kenntniss der Verdauungsvorgänge," and "Zur Verdauung bei den Krebsen," in Untersuchungen aus den physiol. Institut in Heidelberg, Bd. ii.

‡ M. Weber, "Ueber den Bau und die Thätigkeit der sog. Leber der Crustaceen," in Arch. f. mikr. Anat. Bd. xvii. p. 385.

§ J. Frenzel, "Ueber die Mitteldarmdrüse der Crustaceen," in Mittheil. a. d. zool. Station zu Neapel, Bd. v. p. 50.

functioning as an intestine, with a secreting and at the same time absorbent epithelium.

The sucking stomach so characteristic of the Bopyridæ and Entoniscidæ, with the large papillæ projecting into its lumen, is deficient not only in *Cryptothir*, in which, indeed, the larviform fore body would afford no space for it, but also in the other Cryptoniscidæ; in them, evidently, the *intestinum glandulare*, the walls of which perform lively movements, assumes its function.

Finally, as regards the rectum. Its connexion with the anterior part of the intestine is interrupted in the more strongly deformed animals, and we find it only in larvæ and young females. As Buchholz, F. Müller, and Fraisse have already shown, it is inflated into a pear-shape not far from the anus. (In opposition to Fraisse's statements, I find an anus even in the older animals.) Of the bacilliform elements of the contents described by Buchholz I have seen nothing any more than Fraisse; in my sections the lumen of this part is quite empty, as the large cells of the wall project into it like papillæ, and leave only a small stelliform space free in each transverse section. I cannot confirm the statements of Buchholz and Fraisse that pigment cells surround the rectum; the brown pigment deposited in the neighbourhood of the intestine is extracellular, and is probably to be regarded as urinary concretion. Whether we have to do here, as Blanc * supposes, with a separation-product of the fatty body, may be regarded in this case as doubtful, as no distinct fatty-body elements could be demonstrated even in the youngest stages investigated by me. This, however, is no absolute impediment. In the Bopyridæ and Entoniscidæ the fatty body, which is at first very large, is reduced in proportion as the ovary enlarges by the maturation of the ova; and it is comprehensible that in the Cryptoniscidæ, in which sexual products, *i. e.* male products, are so very early developed, the fatty body will also be reduced very early; and in a certain sense it is rendered unnecessary by the *intestinum glandulare*, which, indeed, does not serve for the accumulation of already assimilated nutritive material like the fatty body, but nevertheless accumulates unassimilated food in enormous quantities; and this, as it is assimilated, goes directly to the advantage of the ova. It may, however, be supposed that the urinary masses are separated from a fatty body which existed during the larval period; they are actually present in the greatest

* Blanc, "Observations faites sur la *Tanaïs Oerstedii*," in Zool. Anzeiger, 1883, p. 637.

quantity during the male sexual maturity, and diminish subsequently in amount, not only relatively but absolutely. Nevertheless, I only wish to indicate a possibility; it seems a more probable supposition that these urinary concretions originate in the blood and are deposited in the wall-less blood-lacunæ, the most important of which indeed run along the intestine. The decrease of these pigment-secretions coincides with the commencement of the sedentary mode of life, and therefore also with the complete change of nourishment, and may consequently be caused thereby instead of by the disappearance of the fatty body.

That the rectal vesicle produces a strongly smelling substance, as Fraisse asserts, may be correct; but I cannot confirm it, as unfortunately (or shall I, as a zoologist, say fortunately?) I possess a very feeble sense of smell.

The other internal organs of the Cryptoniscidæ show no great differences from those of the Bopyridæ; what there is to be said about them and about the details of the external organization I reserve for my monographic publication.

II.—*On the* Spongia coriacea *of Montagu,* = Leucosolenia coriacea, *Bk., together with a new Variety of* Leucosolenia lacunosa, *Bk., elucidating the Spicular Structure of some of the Fossil Calcispongiæ; followed by Illustrations of the Pin-like Spicules on* Verticillites helvetica, *De Loriol.* By H. J. Carter, F.R.S. &c.

[Plate I.]

In 1871 ('Annals,' vol. vii. p. 278) I gave a nomenclatural account of Montagu's *Spongia coriacea* = *Grantia clathrus*, Sdt., = *Leucosolenia coriacea*, Bk., = *Clathrina clathrus*, Gray, under the last name, which was subsequently changed by Häckel into *Ascetta clathrus* ('Die Kalkschwämme,' vol. ii. p. 30), and now I propose to add the result of a structural examination, chiefly on living specimens, of this calcisponge from this place, viz. Budleigh-Salterton, South Devon.

In limine, however, it is necessary to clear up the confusion that has arisen from Häckel having made a separate species of Schmidt's *Grantia clathrus* under the name of *Ascetta clathrus*, with a different form of spicule from that which Schmidt has given as characteristic of it (Spong. Adriatisch. Meeres, Suppl. p. 24, Taf. iii. fig. 3 *a*), and which accords with that of all the other authors mentioned but Häckel, who, instead of an equilateral triradiate with straight arms, obtusely pointed, has given one with undulating rays, which are inflated at the ends (*op. cit.* vol. ii. p. 36, Atlas, Taf. v. figs. 3 *d–f*). Now had Häckel offered any explanation of this with reference to Schmidt's original announcement, one could have understood the discrepancy; but he neither refers to Schmidt's characteristic figure of the spicule of *Grantia clathrus* (*l. c.*), nor does he use the specimens which Schmidt gave him in 1868 (*op. cit.* vol. ii. p. 32), but gives the result of his examination of those which he himself found in the spring of 1871 on the coast of the island of Lesina, in the Adriatic Sea, as typical of *Ascetta clathrus* (*ib.* p. 33). Thus we have to choose between Schmidt's published figure of his *own* specimen in 1864 and Häckel's of *his* own in 1872, in which dilemma it is evident that the latter could not have been *Grantia clathrus*, and therefore that Häckel had no reasonable grounds for making it so. Hence the species at Budleigh-Salterton, being the original *Spongia coriacea* of Montagu, must be viewed as Schmidt's *Grantia clathrus* of 1864, and *not* as Häckel's *Ascetta clathrus* of 1872; while as Gray's genus "*Clathrina*" is founded on *Clathrina sulphurea*,= Schmidt's *Grantia clathrus*, which, again, is equal to *Leucosolenia coriacea*, Bk., and occurs here, as elsewhere, occasionally under sulphur-yellow and scarlet colours respectively, we must adopt Bowerbank's or Gray's names for the whole; and as that of the latter is most expressive of the anastomosing tubular structure of *Spongia coriacea*, Mont., while it does not indicate any particular colour or contain any other different structure, such as *Leucosolenia botryoides*, Bk., which is simply *branched* ('Die Kalkschwämme,' Atlas, Taf. ix. fig. 10), it is evident that "*Clathrina*" is the most preferable, as the original generic name of Montagu, viz. "*Spongia*," must necessarily be changed by some one.

Of all the sponges growing on the rocks here that I have seen, no species is more strikingly beautiful than Montagu's *Spongia coriacea*, which, when fresh and extending over an area of about four square inches, presents itself under the form of a reticulated structure of an icy-white colour, in which the reticulation is only just visible to the naked eye, but, when magnified, contrasts favourably, as it veils the dark rock beneath with the most chaste and exquisite network that could be produced artificially. No representations of it hitherto do it full justice in this respect, least of all those of Johnston and Bowerbank.

This network is composed of a hollow anastomosing thread or fibre of variable diameter, whose interstices or meshes (for a parallel illustration of this meshwork see the body of *Leucosolenia lacunosa*, var. *Hillieri*, Pl. I. fig. 2, *a*, *f*, *g*) are subject to infinite variety both in size and shape throughout the specimen, which, when large, thins out from a massive variable amount of thickness in the centre, seldom more than 2 or 3-12ths of an inch, to a single reticulated layer at the circumference. These thickened centres are numerous in a specimen about the size mentioned, and form several little monticular elevations scattered over the surface, whose summits respectively end in a little short open tube with naked margin, which is continuous with the neighbouring branches of the hollow thread-work, and thus forms an osculum or vent to this part of the sponge (see also Pl. I. fig. 3), while the other ends of the thread are blind and attached to the rock over which the sponge may be growing. So that the hollow of the reticulated thread is homologous with the cloacal cavity of the other forms of Calcisponges.

If we follow the development of this structure from the youngest form that can be seen, viz. that which has just come from the embryo, it will be found to consist of a simple erect sac, whose upper end is open and whose lower one is attached to the rock on which it may be growing. This is the commencement of the hollow thread out of which the largest specimen is finally constructed. It may now be about 1-30th inch long by 1-120th inch broad, narrowing to a point at the fixed end. Such are the measurements of the smallest forms which are just now (April 10th) to be seen of all sizes and all stages of development on the rocks at "Straight Point" here, where the species grows abundantly. In the next stage the sac sends out a tubular bud, which may also descend to the rock, and then, as the individual grows upwards and outwards, other similar buds are put forth which either descend to the rocks for fixation or otherwise anastomose with each other, until at last the reticulated structure first described is attained; but how the anastomosis is effected, that is, how the loops are formed, I have not been able to perceive.

Thus the development is very simple, although the adult form appears to be so complicated, and the reticulated structure not by any means confined to *Grantia clathrus* alone, but common to a great many different species of Calcisponges, of which the beautiful little *Leucosolenia lacunosa*, Bk., of the British shores is a stipitate form and also of different spiculation; still, whatever the spiculation may be, the soft parts appear to be similar in all. *Grantia clathrus* consists simply of the spicular structure, the spongozoa (Geisselzellen), and the granuliferous sarcode (syncytium, Häckel).

The form of the spicules or skeletal support, which are chiefly situated in the outer part of the wall of the hollow thread, is of one kind only, viz. equiangular and equiradiate, with simple straight rays, obtusely pointed, as already mentioned.

The spongozoa do not appear to differ in form from those of the other Calcispongiæ, but instead of being arranged in juxtaposition around the interior of globular or sacciform cavities, with their respective cilia projecting into the interior, they appear to form in juxtaposition a continuous layer throughout the inner surface of the tubular thread after this manner.

The "granules" of the sarcode, however, are very remarkable from their size and dominant presence; and although they accompany the transparent sarcode everywhere, they appear when *in situ* among the spicules and spongozoa to be loosely grouped around a delicate nucleated cell respectively, the "Kern" of Häckel.

It is now thirty-five years ago that I gave an illustrated description of this granuliferous sarcode in *Spongilla* ('Annals,' 1849, vol. iv. p. 91, pl. iv. fig. 2, *a–f*) in the living state; and as this seems to apply very nearly to that of *Grantia clathrus* (so far as the dead state of the latter goes in a preparation to be presently mentioned), I will here quote the original paragraph, viz.:—

"If a seed-like body [statoblast] which has arrived at maturity be placed in water, a white substance will, after a few days, be observed to have issued from its interior through the infundibular depression on its surface, and to have glued it to the glass; and if this be examined with a microscope, its circumference will be found to consist of a semitransparent substance, the extreme edge of which is irregularly notched or extended into digital or tentacular prolongations precisely similar to those of the protean [*amœba*], which, in progression or in polymorphism, throws out parts of its cell in this way (pl. iv. fig. 2, *d d*). In the semitransparent substance may be observed hyaline vesicles of different sizes contracting and dilating themselves as in the protean (fig. 2, *e e*), and a little within it, the green granules so grouped together (fig. 2, *f f*) as almost to enable the practised eye to distinguish *in situ* the passing form [polymorphism] of the cells to which they belong; we may also see in the latter their hyaline vesicles with their contained molecules in great commotion, and between the cells themselves the intercellular mucilage" [syncytium of Häckel].

One cannot help observing here that, as the illustration to the paragraph represents, the "granules" appear to have been dragged off their cells (Kerne), to become scattered in the pseudopodial sarcode, which thus also appears to be as homogeneous as that of an *Amœba*. Yet it seems questionable whether the cells from which this apparently homogeneous sarcode has been derived do not still retain their individuality, seeing that, in the conjugation (zygosis) of two Rhizopods, they with their granules appear to flow together as intimately as two drops of water, that is, their individuality becomes lost; they put forth their pseudopods afterwards as if thoroughly amalgamated; and yet, after a little while, they separate and appear to be the same in every respect as they were before the conjugation. Or, these cells and their accompaniments can unmake and remake themselves as the occasion may require and with the materials that are nearest, —*so inexplicable are the phenomena manifested by polymorphic sarcode*!

Such facts would lead us to infer that the syncytium is composed of a congeries of polymorphic cells, which thus simulate a homogeneous substance, just as Rostafinski, and previously to him his teacher, A. de Bary, I think, has stated respecting that wonderful moving fungus *Æthalium*, viz.:—That "the contents of the spores at the time of germination, give rise at first either to a naked zoospore provided with a nucleus, a contractile vacuole and long cilia [? two], or to an amœboid. These zoospores or amœbæ flowing together in masses give rise to mobile plasmodia" (Rostafinski, Dr. J., 'Monografia Sluzowce,' p. 83, in Polish, 1875; ap. Cooke, 'Myxomycetes of Great Britain,' p. 1); while in my observations on *Æthalium* at Bombay in 1861 these apparently homogeneous masses or plasmodia evinced, during the restless unceasing changes in form of the fungus, the power of moving about and running together like so much water, of constricting themselves isthmus-like almost to separation, of flowing back together again, of spreading themselves out dendritically, and finally of ending in a motionless, circular, convex mass, which soon became a heap of black-brown spores!

Returning to the syncytium of *Grantia clathrus* one finds the granules so much more strikingly developed relatively here than in the other forms of Calcisponges, that one cannot help questioning their nature and import.

Taking the granule singly, it is spherical, translucent, and glairy, glistening from refraction of light, of a faint yellow tinge, and varying under 1-6000th of an inch in diameter, although rarely attaining this size in this state. They are, when *in situ*, congregated round a nucleated cell (the "Kern") which is often so indistinct here as to be very difficult to see, owing to its delicate (? polymorphic) structure and the opaque mass which the granules form when closely applied to it in juxtaposition; or they are scattered throughout the syncytium in the same way as in the Foraminifera, as the "preparation," to which I have before alluded, which was made after Schultze's method, described by him in his examination of *Euplectella aspergillum* ('Challenger' Reports, separate copy, p. 5), plainly shows, where the granuliferous protoplasm or syncytium can be seen in a reticulated branched form extending across the cavity of the tubular thread, very much like that of *Gromia oviformis*, represented by Max Schultze in his "Organismus d. Polythalamien" (1854, tab. i. fig. 1). So that one feels inclined to infer that, excepting for its spicules and the spongozoa, the sponge would be very nearly allied to a Foraminifer in this respect.

Iodine does not turn them purple, nor does liquor potassæ dissolve them; but strong nitric acid appears to destroy their sphericity, which may be brought back again by the addition of liquor potassæ. This glairy refractive appearance gives them the aspect of fat or albumen; while, like the green granules in *Spongilla*, they appear in the sulphur-yellow and scarlet varieties of *Grantia clathrus* to be the seat of these colours respectively, when they might be termed "pigmental." It is possible that they grow into the larger cells of the protoplasm (the "Kerne"), from which they appear to be derived, when they may fulfil other offices; for Lieberkühn has long since shown that the "Körperparenchym," = syncytium, can enclose and extract nourishment from Infusoria in the same manner as "*Actinophrys sol*" (Müller's Archiv, 1857, Heft iv. p. 388). So the particles of wood taken into the plasmodia of *Æthalium* indicate the same consequence. But whatever the office of the granules may be no one as yet has demonstrated beyond conjecture what they are or what purpose they may subserve either in the sponges or in the Rhizopoda,—so they are still called "the granules."

The canal-system consists of the usual inhalant and excretory divisions: the former of minute pores which can only be seen by the microscope on the outside of a dried well-preserved specimen, where they are bordered by the granuliferous sarcode or *syncytium*; here, too, probably, in the living state, composed of a congeries of *distinct nu-*

cleated granuliferous cells or bodies like the "investing membrane" of *Spongilla*, which *in combination* there appeared to me to have the power of opening and closing a pore wherever they liked (see "Ultimate Structure of *Spongilla*," 'Annals,' 1857, vol. xx. pp. 24, 25, pl. i. figs. 6, 7); the "Wanderzellen" or migrating, amœboid cells of Schulze (Zeit. f. w. Zool. 1878, Bd. xxx. S. 409 &c.);—and the latter or excretory division, consisting of the general tubulation of the reticulated thread, opening in the way and at the vents mentioned; homologous with the cloaca in the other forms of the Calcispongiæ, as before mentioned.

The process of reproduction by ova &c. is probably the same as that of the other Calcispongiæ; but in the hope of determining this as well as when the elements of reproduction begin to appear, I have gathered living specimens of *Clathrina coriacea*, *Grantia compressa*, and *Grantia ciliata*, var. *spinispiculum* (being together), from the "Rocks" here every full moon (*i. e.* the "springs"), since the 11th of March last inclusive, at which time I could see no trace of these elements in either of these species. They began to appear in the two latter on the 10th of April, and were strikingly developed, especially in *Grantia compressa*, on the 12th of May, but not advanced then beyond the *un*segmented stage. In *Clathrina coriacea* no trace had then appeared; nor is there any now on h e 9th of June, although the fragments (taken from different localities) were placed in pure spirit directly they were taken off the "Rocks," which preserves the collar and the cilium of the spongozoa in their extended state. It is therefore plain that *Clathrina coriacea*, in point of time, does not develop its ova and spermatic cells so soon as *Grantia compressa* and *Grantia ciliata*, var. *spinispiculum*. My observations on the former in this respect for the other summer months will be communicated hereafter.

As before stated, the general structure of *Clathrina coriacea* = *Grantia clathrus* &c., that is, the reticulation formed by the continuous anastomosing of a hollow thread-like fibre or tube, is common to many Calcispongiæ, which Häckel has divided according to their spiculations respectively, so that they appear in several genera of the first two families of his "natural system," viz. the "Ascones" and "Leucones;" but *of themselves* they equally form a natural group in general structure as distinct as it is totally different from that of the other Calcispongiæ, that is, the *anastomosing reticulation.* Moreover, the little Australian calcisponge which I have described and illustrated under the name of *Leucetta clathrata* ('Annals,' 1883, vol. xi. pl. i. figs. 13–17) must form the type of a division of this family, in which the anastomosing thread-like fibre is *solid* instead of *hollow*—a form entirely absent in the "Kalkschwämme" of Häckel, but one of much interest, as I have heretofore shown, in elucidating the structure of some of the fossil Calcispongiæ, which I hope to still further advance by a description of the following new variety of *Leucosolenia lacunosa*.

Leucosolenia lacunosa, Bk., var. *Hillieri*, Crtr.
(Pl. I. figs. 1–5.)

Small, stipitate, erect; body globular, obconic, rather compressed and turned to one side; stem cylindrical and long, rather bent upon itself and compressed in its upper part. Body not hollow, but composed throughout of massive clathrous structure; stem solid (Pl. I. figs. 1, 2). Colour pale yellowish white. Consistence firm, resilient in the head, hard and unyielding in the stem. Clathrous structure or network (fig. 2, *g*) consisting of a mass of reticulated anastomosing thread-like tube (fig. 2, *f*) issuing from the stem in several divisions (fig. 2, *d*), and terminating in the summit by a central dilatation into which the neighbouring branches of the reticulated structure are gathered together centripetally (fig. 3, *b*), finally opening by a single naked aperture more or less protruded, which is the osculum (figs. 2 *b* and 3 *a*). Pores minute, in the wall of the tubular structure. Stem consisting of a compact solid mass of spicules, compressed in its upper part, which is expanded scopiformly into the "divisions" mentioned (fig. 2, *d*), which, being solid like the stem at first, pass respectively by transition into the tubular form which characterizes the structure of the body (fig. 2, *a*), terminating below in a root-like expansion which is fixed to the object on which the sponge may be growing (fig. 2, *e*). Structure and composition of the wall of the reticulated fibre the same as that of *Clathrina coriacea* just mentioned, only the meshes of the network are elongated vertically, which of course is followed in direction by the branches of the tubular thread, *i. e.* from the stem to the summit. Spicules of three forms, viz.:—1. Triradiate, equiangular, inequiradiate, rays straight, smooth, rather obtusely pointed, the longest, which in the largest of these spicules is three or four times longer than either of the other two, directed backwards (fig. 4, *a*); the rest infinitely variable in size generally and in the unequal length of their rays, some nearly equiradiate (fig. 4, *b*); longest ray of the larger triradiates (fig. 4, *a*) about 48-6000ths inch long by 2-6000ths inch broad at the base. 2. Linear, acerate in appearance, but consisting of two unequal portions divided by a slightly inflated *node* which belongs to the longest part, and is therefore a little excentric (fig. 5, *c*); divisions smooth, but more or less varying in thickness here and there, especially towards the ends, which are obtusely pointed; one division straight and the other a little curved so as to form a very slight angle with the straight one; largest average size about 91-6000ths inch long by 2-6000ths inch broad (fig. 5, *a*). 3. Linear-vermiculate, smooth, attenuated towards the extremities, which are pointed; divided like the foregoing by an excentric *node* (fig. 5, *c c*); amount of vermiculation and total length very variable, the smallest perhaps about 16-6000ths inch long by 1-6000th inch broad, but immeasurable generally, from the amount of contortion (fig. 5, *b b*); increasing in size and decreasing in vermiculation so as at last to reach an intermediate form (fig. 5, *d*). The triradiates are equally present in the body and stem; but the linear and vermiculate spicules are *exclusively* confined to the latter, where they form the *outer* layer and the triradiates the *axial* or internal structure; they do not begin to appear before the stem begins to divide into the branches leading to the head (fig. 2, *d*), and then go on increasing in number and robustness, although not in length, down to the root-like expansion or oldest part, as is usual in most sponges. Size of largest specimen (fig. 1) 9-12ths inch in total length, of which the body is 3½-12ths, and the stem the rest, viz. 5½-12ths inch; greatest diameter of the body about 3-12ths inch, that of the stem close to the body 1-12th, and that towards its base 1-24th inch.

Hab. Marine; growing on hard substances.

Loc. Ramsgate pier, Ramsgate.

Obs. Independently of the interest attaching to this sponge as a variety of *Leucosolenia lacunosa*, Bk., it is still more interesting as presenting a spiculation and structure which reveal the nature of the "filiform spicules" and structure of the fibres in some of the fossil Calcispongiæ from the "Coral Rag" of Faringdon in Berkshire.

These spicules, although first represented by Zittel, in 1878, in *Peronella multidigitata* (Abh. k. bayer. Akad. d. W. ii. Cl. Bd. xiii. 2 Abth. Taf. xii. fig. 3), were just afterwards, that is in the same year, more particularly described and illustrated under the above name, viz. "filiform spicules," by Sollas ('Annals,' 1878, vol. ii. p. 356, pl. xiv. figs. 1–5); and subsequently described by myself ('Annals,' 1883, vol. xi. p. 22).

Until Zittel had kindly convinced me by a microscopic preparation of *Peronella multidigitata* from the Cretaceous of Le Mans, that Calcisponges existed in a fossilized state, I was inclined to discredit the fact, as my actual experience of the delicate structure and perishable nature of the spicules of the Calcispongiæ then seemed to point out that their structure and spiculation was such that they must inevitably go to pieces immediately after death, and therefore that the probability of a Calcisponge becoming fossilized was very doubtful.

When, however, convinced of the error I fully expected that recent specimens would be discovered which would explain all the then anomalous structure and spiculations in the fossil ones; and the first that tended chiefly towards this was the discovery, by Dr. Hinde, that the fibre of his *Verticillites d'Orbignyi* from the Upper Greensand of Warminster was composed of three- and four-rayed calcisponge-spicules, which were so far loosened by disintegration that they could be easily extricated entire, and thus viewed under the microscope, mounted in balsam or otherwise, indeed a simple lens is sufficient ('Annals,' 1882, vol. x. p. 192 *et seq.* pl. xi.). At the same time Dr. Hinde discovered in his *Sestrostomella rugosa* from the Cretaceous of Vaches Noires, near Havre (ibid. pl. x. fig. 4, and pl. xii. fig. 12, &c.), the two-pronged "tuning-fork"-shaped minute spicule first represented by Dr. Bowerbank (Mon. Brit. Spong. vol. i. p. 268, pl. x. fig. 237) from a *recent* calcisponge at Freemantle, in S.W. Australia, and subsequently by Häckel in his *Leucetta pandora* from the Gulf of St. Vincent &c. in S. Australia ('Die Kalkschwämme,' Atlas, Taf. xxiii. fig. *h*). I was myself able also to confirm these observations respectively in *Verticillites anastomans* from the Coral Rag of Faringdon and in a specimen of *Sestrostomella* from the Jura, kindly sent me by Zittel, when I also published the illustrated description of the little calcareous sponge from Freemantle, in which the clathrous structure was shown to be formed by the reticulated union of a thread-like element similar to that of *Clathrina coriacea* and *Leucosolenia lacunosa*, but, as before stated, *solid* like the stem of the latter, and *not hollow* like the tubular thread of the head, being composed of a layer of small triradiates externally with a much larger and different triradiate-form axially or within ('Annals,' 1883, vol. xi. p. 33, pl. i. figs. 13–15); and now I have had the opportunity of describing one from the coast of England, in which the "filiform spicules," together with the *solid* fibre in the fossil species, also receive an explanation from a *recent* species.

The specimens of this sponge, which are in spirit, were gathered on the pier at Ramsgate by Mr. Hillier, after whom I have designated the variety, and presented to me by Mr.

B. W. Priest in September 1882, when I thought, from their resistance and apparent durability on being handled, that had I been acquainted with them earlier I should never have discredited the fact that a calcisponge could be fossilized. Thinking, however, from their resemblance that they were specimens of *Leucosolenia lacunosa*, I put them aside under this belief; but lately I have had to examine them in connexion with the foregoing species, viz. *Clathrina coriacea*, and then I perceived that the solidity of the stem and its spicular composition were like the fibre of *Peronella multidigitata*, Zittel, of ?*Scyphia perplexa*, Quenstedt (tab. 125. fig. 63), and of *Manon peziza*, also Quenstedt (t. 132. fig. 30), respectively; that is, that it was composed of triradiates in the centre faced by a layer of linear and vermiform spicules, each of which indicated by the kind of *node* mentioned (Pl. I. fig. 5, *c c c*) near the centre, which slightly projects, that it represented the aborted state of a third ray, and thus a modification of the triradiate.

Now, when we consider that the stem, as it approaches the body (Pl. I. fig. 2, *d*), divides into a multitude of branches, each of which, although *solid* in the first instance, becomes transformed into a *tube* to form the tubular thread of the body (fig. 2, *f*), which by branching and anastomosing produces the clathrous structure in which the linear and vermicular spicules are *entirely absent*, and that the linear and vermicular spicules thus cease to appear *where the transformation takes place*, it follows that had the branches continued *solid* like the thread of the clathrous structure in *Leucetta clathrata*, Crtr. (*op. et loc. cit.*), they would have been *identical* in spicular composition and arrangement with the fibre of the fossils mentioned, where, on account of their contortion being perhaps more generally greater than that in *Leucosolenia lacunosa*, var. *Hillieri*, the extreme thinness of the microscopic slice cutting off the bends above and below, seldom allows one to be seen entire. Indeed the more contort ones in *Leucosolenia Hillieri* during the boiling out in liquor potassæ, from this together with the brittleness of the material, for the most part, come out broken. Thus the "filiform spicules" of the fossil Calcispongiæ seem to be elucidated.

Pin-like Spicules (? parasitic) on *Verticillites anastomans* and *A. helvetica*. (Pl. I. figs. 6–10.)

At the conclusion of my paper on the Fossil Calcispongiæ of Faringdon ('Annals,' 1883, vol. xi. p. 33) I had only just time to mention Dr. Harvey B. Holl's discovery of pin-like spicules in that variety of *Verticillites* designated "*helve-*

tica" by De Loriol; so I returned to the subject (*ib.* vol. xii. p. 26), when by having made and mounted microscopic sections myself, I was enabled to give a more detailed description of the fact, and to announce that such spicules also existed in the same position in my specimens of *Verticillites anastomans* from Faringdon; but on neither occasion had I time to illustrate this interesting discovery, which is so likely to pass unnoticed without representations, that I have availed myself of the present opportunity to fill up a vacant space with these, taken from my own preparations (Pl. I. figs. 6–10).

EXPLANATION OF PLATE I.

Fig. 1. *Leucosolenia lacunosa*, var. *Hillieri*, n. var. Natural size.

Fig. 2. The same, magnified 3 diameters, to show:—*a*, body, composed throughout of massive clathrous or reticulated structure. Body not hollow. *b*, vent or osculum; *c*, stem; *d*, scopiform expansion of stem into reticulated structure of body; *e*, root-like attachment; *f*, tubular thread-like fibre; *g*, meshes of clathrate structure.

Fig. 3. The same. Summit more magnified, to show the continuity of the vent with the reticulated tubular structure of the body. *a*, vent; *b*, tubulated thread or fibre; *c c*, meshes or interstices of the reticulated structure.

Fig. 4. The same. Triradiate spicules of the body and centre of the stem respectively. *a*, largest form; *b*, smallest; *c*, dotted line, illustrative of the inequiradiate forms.

Fig. 5. The same. Substraight linear and linear contort spicules of the stem. *a*, substraight linear; *b b*, linear contort; *c c c*, nodes; *d*, intermediate form.

N.B.—All these spicules are drawn to the scale of 1-24th to 1-6000th inch.

Illustrations of the Pin-like Spicules (? parasitic) &c. on Verticillites.

Fig. 6. *Verticillites helvetica*, De Loriol. Horizontal section of the wall of a cylinder at the inflation, magnified 4 diameters, to show the structure of the wall and its hourglass-shaped openings or canals. *a*, cavity of inflated chamber; *b*, wall, apparently composed of little oval and quadrangular elements, because, in some instances, the section has passed through the hourglass-shaped canals, and in others not. Diagrammatic.

Fig. 7. The same. Vertical section of part of the wall of a cylinder at the inflation, viewed from the *inside*; magnified on the same scale, to show the structure of the wall and its hourglass-shaped openings in *this* view. *a*, wall, *now* seen to be continuous and not formed of separate elements, as the foregoing figure apparently represents; *b*, inner opening of the hourglass-shaped canals, with a dot in the centre, to represent the narrow part. Diagrammatic.

Fig. 8. The same. Horizontal section of two of the so-called "oval elements" with the hourglass-canal between them filled with sand; magnified on a scale of 1-24th to 1-1800th inch. *a*, outside of inflation; *b*, inside; *c c*, so-called "oval elements," composed of homogeneous crystalline calcite, with minute fibrous structure (? product of fossilization); *d*, hourglass-shaped canal filled with grains of quartz-sand; *e e e*, pin-like spicules *in the* "calcite," arranged around the funnel-shaped openings of the hourglass-canals outside respectively, as will be better understood by the next figure, but here only seen in the section, where they may be observed to slope inwards with the *head externally*; *f f*, row of triradiate spicules *in the* "calcite" within the pin-like spicules. Diagrammatic, with the detail relatively magnified.

Fig. 9. The same. Pin-like spicule, more magnified, to show its shape and relative proportions.

Fig. 10. The same. Vertical section of a portion of the wall at the inflation, viewed from the *inside*, magnified to the same scale (see a less magnified portion, fig. 7). *a a*, wall composed of the homogeneous crystalline calcite with minute fibrous structure before mentioned; *b b b*, constricted parts of the hourglass-shaped canals, respectively filled with quartz-sand, also as before mentioned; *c c c*, position of the triradiate spicules in the wall around the hourglass-canals, shown by their truncate ends; *d*, part of the slice where the layer of triradiates has been ground off, showing that *e e e*, the cross-sections of the pin-like spicules, are in circles, indicative of their infundibular mode of arrangement around the external openings of the hourglass-shaped canals. Diagrammatic, with the detail relatively magnified.

III.—*Some Remarks upon the Variability of Form in* Lubomirskia baicalensis, *and upon the Distribution of the Baikal Sponges in general.* By Dr. W. Dybowski *. With P.SS. by H. J. Carter, F.R.S. &c.

[Plate II.]

During the printing of my memoir on the sponges of Lake Baikal †, I received from Irkutsk, from my brother Dr. Benedict Dybowski, a photographic representation, prepared by him, of *Lubomirskia baicalensis*, and also a communication upon the general occurrence and distribution of sponges in Lake Baikal. These notes possess no little scientific interest, and may therefore serve to complete my memoir, so that I regard it as advisable to publish them as a brief supplement to my work above cited.

* Translated from a separate copy, communicated by Mr. Carter, of the paper published in the 'Bulletin de l'Académie des Sciences de St. Pétersbourg,' tome xxvii. pp. 45–50.

† W. Dybowski, "Studien über die Spongien des russischen Reiches mit besonderer Berücksichtigung der Spongien-Fauna des Baikal-Sees," in Mém. de l'Acad. des Sci. de St. Pétersb. sér. 7, tome xxvii. no. 6 (1880).

The variability of the sponges in regard to their morphology is a generally known fact. That *Lubomirskia baicalensis* follows this general rule we have a satisfactory proof in the material before us.

The morphological variability of *Lubomirskia baicalensis* has already attracted the attention of Miklucho-Maclay *; but, as may be concluded from his words (*l. c.* p. 8), he was acquainted only with inconsiderable variations. In order to furnish as complete a description as possible of the form and structure of our sponge, I will here summarize all that is already known upon the subject, and enlarge it by my own observations. But, remarkable as are the differences in the form of the sponge under consideration, all these morphological deviations may always, by careful investigation, be referred to one and the same type.

The simplest and therefore typical form of our sponge is that of an arborescent stem with cylindrical erect branches †. The branches originate sometimes at different heights (see Miklucho, *l. c.*), but sometimes at the same level (see Dybowski, *l. c.*).

This simplest form as just described is modified in various ways, and the most important modifications are the following:—

I. Forms in which the type is distinctly recognizable.

a. The erect cylindrical branches of the sponge are not free throughout, but unite with one another by several transverse anastomoses of various thickness and length (see Dybowski, *l. c.* p. 12, tab. i. fig. 1).

b. The erect cylindrical branches of the sponge stand so close to each other or to the stem that at the surfaces of contact they coalesce either with one another or with the main stem. By this means there are formed very variously shaped, elongated, more or less flattened bodies, from the top of which larger or smaller branches originate (see Pl. II. fig. 1 *b*).

II. Forms in which the type is almost entirely effaced.

a. Arborescent sponges.

α. The branches do not stand erect, but form a more or less acute angle with the main stem. The individual branches are not cylindrical, but thinner at the free extremities than at the base. (Specimen in my collection.)

β. The short nearly cylindrical branches are pinnately arranged; but

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* Miklucho-Maclay, "Ueber einige Schwämme des nördlichen Stillen Oceans und des Eismeeres," in Mém. de l'Acad. des Sci. de St. Pétersb. sér. 7, tome xv. no. 3.

† See Dybowski, *l. c.* tab. i. fig. 1; Miklucho-Maclay, *l. c.* tab. i. fig. 5; and Middendorff, 'Sibirische Reise,' Bd. iv. Theil ii. Lief. 1, p. 1065.

they originate only from one side of the stem (semipinnate) (see Pl. II. fig. 1 *c*).

b. Bush-like sponges. When numerous twigs grow forth in various directions from a short and thick base, a bush-like form is produced (Pl. II. fig. 1 *a*). In such a bush we observe very differently formed twigs. Most of them are furcate and grow together in their lower part. The size of a bush is sometimes enormous.

With regard to the occurrence and distribution of the sponges in Lake Baikal, my brother sends me the following information * :—

In the south-western portion of Lake Baikal †, that is in the whole stretch from Listwiennischnaja and Possolsk on the one hand, to Kultuk on the other, the sponges occur wherever the necessary conditions are present ‡.

As a rule the sponges occur wherever the bottom of the lake is stony and where large blocks of rock or wood are lying about on it; further numerous sponge-stocks are found in those places where the steep rocky shore forms terraces projecting into the water in steps. On the other hand, if the bottom be sandy, muddy, or covered with small easily movable stones, no sponges occur. At a depth of 100 metres therefore, where the bottom is always covered with fine mud, a few small coating stocks occur only where large blocks of stone or logs of wood project out of the mud. On the western shore these conditions are abundantly realized, so that here sponges are almost everywhere met with. Close to the shore, and in only inconsiderable depths, turf-like or cushion-like sponge-stocks exclusively occur; globular ones are rare, arborescent forms are never found. The sponges usually are firmly attached to the surface of large pieces of wood or rock; they show, however, a special inclination for rotting wood, so that in certain places almost every log of wood bears sponges. Sometimes one finds large logs which are regularly coated with a crust of sponges.

In considerable depths, as, for example, at a depth of 3 fathoms (=6·3 metres), often quite close to the steep rocky shore, bush-like sponges exclusively occur. In fine still water, when the surface of the lake is as smooth as a

* In the absence of a monographic treatise on the Baikal sponges the observer only distinguishes the arborescent from the turf-like or cushion-like stocks. The separate species or varieties are not specially treated, but only the conditions of the Baikal sponges in general.

† See Dybowski, *l. c.* p. 7, fig. 1.

‡ Extract from a letter dated "Irkutsk, 1878."

mirror, if we go about in a boat we can delight ourselves with the sight of numerous beautiful colonies of sponge-bushes growing up from the bottom of the lake. The bushy sponges sometimes attain an enormous size. One of them brought up by the dredge was so large that it by itself filled the whole bag of the dredge*. Such large stocks, however, are rare; usually the size of the sponge-bushes does not exceed 60 centim.

At a depth of 6–25 metres, arborescent or fruticose sponges occur; at greater depths only cushion- or turf-like sponges.

At a depth of 100 metres (the greatest depth at which sponges have as yet been taken) we find only occasionally a few small and flat stocks, and even these only when the above-mentioned conditions are realized.

On the eastern shore the bottom of the lake is generally covered with sand or with small easily movable stones; therefore the sponges are here much scarcer. On the larger blocks the sponges only rarely occur, because the west winds, which are here prevalent, cause a continual succession of waves, which is evidently injurious to the growth of the sponges. On the rocky terraces of the shore there are a few cushion-like sponges, but not in such abundance as on the other side, on the western coast of the lake.

In the Angarà (see Dybowski, *l. c.* fig. 1) the sponges occur everywhere in great abundance from the mouth up to the Taltzinskaja manufactory. They are exclusively turf-like or lamelliform sponges, which adhere to large logs of wood and blocks of stone or to smaller pieces of wood; arborescent forms never occur; evidently the sponges require still water in order to become developed in the arborescent form.

Between the Taltzinskaja manufactory and the city of Irkutsk sponges occur much more rarely, as here large stones and logs of wood are less numerous. Above Irkutsk the Angarà has not yet been examined for sponges.

If we briefly summarize all that is known with regard to the distribution of the Baikal sponges, the following may be said:—

1. Close to the shore of the lake, at a depth of 2–6 metres, only turf-like.

2. At a depth of 6–25 metres, arborescent or fruticose.

3. At a depth of 25–100 metres turf-like stocks again occur. At all these depths, of course, the sponges only exist under the above mentioned favourable conditions.

* The bag holds about 40 pounds of mud.

The colour of the sponges is for the most part more or less dark grass-green; sometimes, however, they occur olive-green or brown; only those sponges which come from considerable depths (60–100 metres), or have grown under stones, are almost colourless. The sponges of an indeterminate dingy greyish colour are probably dying or dead stocks.

The following parasites have hitherto been observed upon the Baikal sponges—*Gammarus parasiticus*, *G. violaceus*, and *G. violaceus* var. *virens**.

[P.S.—On the 29th of May last I received from Dr. Dybowski small fragments of all the freshwater sponges from Lake Baikal in Central Asia and the Pachabica-See at its south-west extremity that he had described and illustrated in the 'Memoirs of the Imp. Acad. of St. Petersburg' (tomes xxvii. and xxx. nos. 6 and 10, 1880 and 1882 respectively), together with one of his "*Dosilia* (?) *Stepanowii*," from the neighbourhood of Kharkow in Southern Russia, to which I alluded in the 'Annals' of April last (p. 272), by which I have been enabled, through microscopical examination, to confirm all that he has stated of the forms of their several spicules, especially those of the latter, of whose statoblast Dr. Dybowski kindly sent me a sketch on the 30th May last, to show that it possessed a tubular extension of the chitinous coat, accompanied by the cirrous appendages and armed with statoblast-birotules of different lengths, like those of Mr. H. Mills's *Carterius* (olim *Carterella*) *tubisperma* from the Niagara River; but on comparison with a mounted specimen of the latter, I find *D. Stepanowii* sufficiently different to merit a distinct appellation. During my examination of the material above mentioned I have been struck with the ability and accuracy of Dr. Dybowski's observations, hence look forward with much pleasure to his description and illustrations of the statoblasts of his "*Dosilia* (?) *Stepanowii*," which he intends to publish on the earliest opportunity.—H. J. C.

P.P.S.—In another letter from Dr. W. Dybowski, dated 1st June, he sends me sketches of the statoblast of Mr. Potts's *Spongilla friabilis*, Leidy, var. *segregata*, which was also found near Kharkow, in Southern Russia, thus adding another locality to those already mentioned of this species.—H. J. C.]

* Dr. B. Dybowski, "Beiträge zur näheren Kenntniss der in dem Baikal-See vorkommenden niederen Krebse aus der Gruppe der Gammariden," in the Horæ Soc. Entom. Ross. Beiheft zu Bd. x. p. 75, tab. x. fig. 3, p. 76, tab. xii. fig. 5, p. 147, tab. iii. fig. 3 (St. Pétersbourg, 1874).

EXPLANATION OF PLATE II.

Fig. 1. *Lubomirskia baicalensis*, Pallas, sp. About one third of the natural size. Three specimens, viz. *a*, *b*, and *c*. From a photograph.

Fig. 2. The same. Skeletal spicule, lateral view and transverse section. Magnified 650 times. *a*, lateral view; *b*, transverse section. (Mém. de l'Acad. Imp. d. Sc. St. Pétersbourg, 7e série, t. xxvii. no. 6, Taf. ii. fig. 5, *b*.)

IV.—*Descriptions of three new Species of Moths from the Island of Nias.* By A. G. Butler, F.L.S., F.Z.S., &c.

The three following species were added last year to the National Collection; two of them are especially interesting, as affording an admirable instance of protective assimilation.

Agaristidæ.

Ophthalmis decipiens, sp. n.

Allied to *O. mollis*; grey-blue, with a faint greenish tinge; veins black; the basal third of primaries crossed obliquely by irregular black stripes, the last two of which form an *8*-shaped character from the subcostal nearly to the submedian vein; an oblique black-bordered oval marking immediately beyond the cell; a very irregular black band from costa to submedian vein, where it runs inwards to join the oval marking; the veins between this band and the external border more broadly black than on the rest of the wing; external border black, gradually narrowing from costa to external angle, and dentated internally upon the veins; fringe white at apex and external angle: secondaries with the basal fourth blackish; a large black spot over the end of the cell, beyond which the veins are black; a broad and very irregular black external border enclosing a nearly marginal series of elongated blue-grey spots; fringe white: body above black, spotted in front with white, but the abdomen and sides of thorax banded with pale bluish grey; anus orange. Wings below nearly as above, but the black markings much broader and the blue consequently narrower; all the wings with a large black spot over the end of the cell: body orange; legs striped, and base of venter banded with black. Expanse of wings 51 millim.

Chalcosiidæ.

Laurion zebra, sp. n.

Allied to *L. obliquaria* of Borneo and Malacca; primaries black, with a >-shaped blue marking at basal third of costa, followed by a broad, oblique, snow-white, externally blue-edged belt from costa to external angle; veins beyond the belt bluish; a blue and white subbasal dot: secondaries reddish orange, with the base, costa, and a rather broad external border black; a strongly dentated greenish-blue marginal stripe; thorax black; head dotted with blue and white; abdomen dull black, regularly banded with creamy white. Wings below somewhat as above, but the primaries with one or two subbasal blue-edged white spots, an oblique lunulated bluish stripe just before the middle, apical area greenish blue, with black longitudinal stripes between the veins; secondaries with a pale blue basal spot; the dentated blue margin covering the outer half of the external border. Pectus black, spotted with bluish white; venter broadly banded with white. Expanse of wings 68 millim.

At once separable from *L. obliquaria* by the great width and white colour of the belt across the primaries, and the absence of the black spot on the orange area of the secondaries.

Euschemidæ.

Panœthia simulans, sp. n.

Has the general aspect of *Ophthalmis decipiens*, but is of a paler blue-grey colour; the wings are crossed by four oblique series of black markings, the first consisting of unequal oval spots, the third much the largest, but those on the secondaries subconfluent; the second series consists of two reversed curved lines united by cross lines at the extremities upon the costal margin and the first median branch; below this is a pyriform spot on the internal border, followed by a squamose black line across the secondaries; the third series consists of unequal oval spots, the second and fifth large and double on all the wings; lastly, a series of elongated black spots gradually lengthening and widening towards the costa of the primaries, where they unite so as to represent the black border on the *Ophthalmis*; body blue-grey, thorax banded with dull grey; abdomen with the last three segments bright ochreous. Wings below duller than above, the black markings badly defined; pectus grey; venter bright ochreous. Expanse of wings 48 millim.

A more elegantly formed species than *P. georgiata* and differently marked.

V.—*On the Systematic Position of the* Pulicidæ. By Dr. Karl Kräpelin *.

[Plate III.]

After my investigations on the buccal organs of the Diptera and Rhynchota † had led me to the conclusion that in the former the true sucking-tube (not to be confounded with the labium, which serves only as its sheath) was formed by a dorsal and a ventral half-gutter (labrum and hypopharynx), and in the latter by two double half-gutters laterally interlocked, it seemed natural to study also the aberrant members of the two series in the light of this criterion, which applied to all typical forms, in order to arrive at greater clearness with regard to their relationships. In this respect no small interest undoubtedly attaches to the group Pulicidæ, which, notwithstanding much difference of form, presents such a uniformity of organization, and as to the systematic position of which for more than a century the most different opinions have been expressed, without any generally acceptable and well-established view having yet been arrived at.

The history of these opinions has already been given pretty completely by Taschenberg in his Monograph on the Fleas ‡, so that here a short recapitulation may suffice.

Linné, as is well known, created an order Aptera for the wingless insects, Myriopods, Spiders, &c., and in this the flea found its place. A similar position was assigned to it by Geoffroy, Cuvier, and Duméril, as also by Gervais; while, on the other hand, the order Aptera was by many rejected as unnatural, and the relationship of the Pulicidæ with various winged insects was asserted. Thus Kircher referred them to the Orthoptera, Fabricius and Illiger to the Rhynchota, Rösel, Oken, Strauss-Durckheim, Newman, Burmeister, Walker, Von Siebold, and others to the Diptera. Lastly, there were also very early naturalists who would associate the flea with none of the existing orders of insects, but postulated a distinct order for it. The leader in this direction is De Geer. He was followed by Lamarck, Latreille, Kirby and Spence, MacLeay, Leach, Dugès, Bouché, and Van der Hoeven, and,

* 'Festschrift zum 50-jährigen Jubiläum des Realgymnasiums des Johanneums,' Hamburg, 1884. Translated by W. S. Dallas, F.L.S.

† In part set forth in the preliminary communication "Ueber die Mundwerkzeuge der saugenden Insekten" (Zool. Anz. 1882, pp. 574–79) and in a memoir, "Zur Anatomie und Physiologie des Rüssels von Musca" (Zeitschr. f. wiss. Zool. xxxix. pp. 683–719).

‡ Taschenberg, 'Die Flöhe' (Halle, 1880).

among later investigators, by Landois and Taschenberg. But although the last two authors especially pronounced most decidedly in favour of the independent position of the Fleas in the system, and although the most accepted special works upon the Diptera exclude the Fleas as not belonging to the series of forms in that order *, we find that even in the most recent manuals of zoology the group of insects in question is almost without exception cited as a suborder of the Diptera. This may pass in the first place as a proof that really stringent arguments have not yet been brought forward in favour of either view ; but we might also derive the hesitation felt by many zoologists to raise the rank of the Fleas (even under otherwise sufficient grounds) from the circumstance that they lead a *parasitic* existence, and by this means have possibly undergone profound and peculiar morphological changes by "adaptation," as is sufficiently established for other groups of parasitic forms. In opposition to this, however, it must be remembered that with only isolated exceptions (the females of the Sarcopsyllidæ) the Pulicidæ are not stationary, but only *temporary* parasites, that their whole development is completed without parasitism, and that therefore we cannot well assume any considerable adaptation to a parasitic mode of life. But if this be so, if we succeed in proving that the Pulicidæ possess a series of morphological characters which cannot be regarded as acquired by parasitism, we must necessarily, in judging of their position in the system, consider the same points of view to be prescriptive that have been generally adopted for the establishment of orders, suborders, and families in the class of insects.

These general points of view, however, do not offer us a very brilliant prospect. The Linnean *principium divisionis*, the form, number, and texture of the wings, having proved to be untenable, we find on the one hand the kind of transformation and its various stages, and on the other the structure of the organs of the mouth, raised into the most important criteria of the nearer or more distant relationship of the groups of insects. But, as is always the case, when a single character is thrown too much into the foreground, and the general morphological relations of the two series of forms are not allowed to be prescriptive, difficulties make their appearance even with these apparently so thorough-going principles of division, which considerably diminish their value. The

* It is interesting that the well-known work on the Diptera of the 'Fauna Austriaca' by Schiner certainly expresses itself decidedly enough in the above sense, but then gives a definition of the true Diptera, which might very well embrace the Pulicidæ.

group of the Orthoptera, which is certainly not very natural, and their multifarious relations with the Neuroptera, the suctorial Apidæ, the biting Mallophaga, and lastly the pupal rest of the male Coccidæ, may sufficiently establish this proposition. It is still worse, however, as regards general availability, with the distinctive characters of the orders generally cited—the segmentation of the thorax and tarsi, the structure of the wings, of the different buccal organs, antennæ, &c. The mere fact of the agreement or difference of these organs individually cannot give us certainty as to the systematic relationship of two series of forms, but only the examination whether the general organization of one group, as expressed in the development of all morphological characters, shows or does not show *phylogenetic relations* with those of another group; in other words, whether the observed differences in the structure of the parts may be referred equally well to a different "fundamental plan" in their arrangement, as to simple changes of form and reductions, such as may be explained by altered function. Self-evident as this proposition appears in the light of modern zoology, the history of opinion as to the systematic position of the flea nevertheless shows very plainly how little it has hitherto been taken into consideration by entomologists. One important aid in such investigations upon the true phylogenetie relationships of forms is unfortunately at present still almost wholly shut out from us. I refer to the anatomical structure of the organs. The knowledge of this, and especially that of the generative organs, is at present so imperfect that a detailed consideration of the internal organization seems to be of little use in the classification of insects.

After these prefatory remarks upon the principles which are or should be of force in the grouping of insect-forms, the question as to the systematic position of the Pulicidæ may be postulated as follows:—Do they or do they not, in the totality of their organs, show near relations of affinity with any of the other groups of insects? In the former case we should have to arrange them in this group of insects; in the latter we must establish an independent order for them.

I naturally commence my examination with that order of insects which, in the judgment of zoologists, has the most right to receive the Pulicidæ into it, namely the Diptera. The series of the Diptera must decidedly be called a unitary one; but the two characters so often brought prominently forward (a perfect metamorphosis and suctorial buccal organs) do not alone establish this unity, seeing that we must also ascribe them to the Lepidoptera, the Apidæ, and the male

Coccidæ. Nay, even if we add the footless larvæ and the fusion of the thoracic segments as further criteria, we might perfectly well unite the Bees with the Diptera. It is not the simple fact of the suctorial buccal organs that is of importance, but their specific structure, the position and arrangement of the parts composing the suctorial apparatus. If we fix our attention upon this point we at once recognize that the fly's proboscis is constructed upon a perfectly different fundamental plan from that of the Apidæ, that the two are not directly phylogenetically referable to each other, but that, on the other hand, the great variations in the buccal apparatus of the Diptera only represent modifications of one and the same type, distinctly demonstrable throughout. The characteristic of the bee's trunk consists in the development of the *lower* parts of the mouth into the sucking organ, while the mandibles retain their original function; that of the fly's proboscis, on the contrary, in the employment of the labrum and hypopharynx for the formation of the sucking-tube, with which the mandibles and maxillæ associate themselves as stylets more or less developed as required, while at the same time the labium in all cases has to form a protective sheath for the comparatively delicate tube through which the fluids ascend. This fundamental plan of the employment of the parts of the mouth occurs, as already pointed out in the introduction, in all the groups (except the Pulicidæ) which have hitherto been placed in the group Diptera, in the piercing Culicidæ, Tabanidæ, and Asilidæ, the different families of honey-suckers, and the Pupipara, which are so depressed in position through parasitism; nay, a bridge seems even to be thrown over towards the rudimentary buccal organs of the Œstridæ, through the structures which occur in *Cuterebra*. In figs. 1–3 (Pl. III.) I have drawn transverse sections of the proboscides of those groups of flies which, upon one hand or the other, have been referred to as allied to the flea. While those of *Tabanus* and *Culex* (figs. 1 and 3) agree not only in the position but also in the number of the pieces composing the proboscis, that of *Melophagus* (fig. 2, the representative of the Pupipara) shows a great reduction, which finds its expression in the entire absence of the mandibles and maxillæ*; but

* The two valves embracing the proboscis of the Pupipara have been very erroneously interpreted as maxillæ, their palpi, or even as a bipartite epipharynx (Meinert). From the whole arrangement of the proboscis, which is freely movable in a wide cavity of the head extending as far as the prothoracic ring, we can here have to do only with a conical prolongation of the head which has become paired, somewhat such as we should obtain if we imagined the slight emargination at the apex of the frontal cone of *Rhingia* carried down to its base. The strongly projecting cheeks of many Conopidæ might also perhaps be regarded as analogous.

nevertheless it is easy even here to recognize the typical position of the pieces forming the sucking-tube (dorsally the labrum and ventrally the hypopharynx), and the labium which encloses these as a sheath. Further, the latter bears at the end that enlarged portion which is so characteristic of all Diptera, and which is probably to be interpreted as formed by uniarticulate labial palpi.

The same unity in the Diptera appears also in the special structure of the thorax and its appendages. That this appears always separated from the head by a deep incision is certainly not without significance; but it can furnish no decisive datum for the collocation of the Diptera. Of more importance, no doubt, is the fusion of the thoracic segments into a compact thoracic mass, which occurs in all the forms referred to this group. It is indeed true that in orders of insects (I refer particularly to the Rhynchota) the formation of the thorax as regards the separation or fusion of the segments composing it shows manifold differences, without its being necessary that we should separate forms which are united for other reasons, seeing that the fusion or separation of the thoracic segments has to do essentially with a function of the mechanism of flight, and the free segmentation of the thorax in a wingless form may very well be explained as a correlative phenomenon of adaptation. But the conditions are different if, on the contrary, a wingless form exhibits complete amalgamation of the thoracic segments. In my judgment it thereby demonstrates most unmistakably its descent from winged insects, and in this sense the compact structure of the thorax, with the characteristic process of the mesothorax described as the "scutellum," in *Melophagus*, the Nycteribiidæ, and the Braulidæ, decidedly acquires the significance of a still uneffaced relationship with the winged groups standing next to them. And just as on account of this character the assumption is justified that the forms just mentioned stand in close phylogenetic relationship with winged insects, so does the examination of the dorsal appendages of the thorax lead to the same conclusion. All Diptera do not possess a pair of wings and a pair of halteres; but the two organs which, because special, are certainly of such great importance in characterizing the Diptera, disappear so gradually in the continuous series of forms, that we may trace their progress to the rudimentary state, as it were, step by step. An *Ornithobia pallida* which, as *Lipoptena cervi*, follows a perfectly different mode of life, enables us at once to understand the case, when we see *Melophagus*, which is never parasitic upon birds, entirely destitute of wings. But as regards the halteres, these, notwithstanding Schiner's assertion to the contrary, are quite recognizable in the sheep-tick, while in the Nycteribiidæ they show all gradations down to quite minute points, so that the complete absence of these apparently insignificant organs in the Braulidæ need not give us any further disturbance. The *ventral* thoracic appendages, the legs, certainly present but few differences in the group of the Diptera, nevertheless the five tarsal joints which are usually present are not always constant; and further, other orders of insects sufficiently prove how little importance attaches in general to the number of tarsal joints and the development of the different sections of the legs.

The *developmental stages* of the Diptera do not show a community of type so distinctly as the structural characters just referred to. The larvæ are certainly throughout distinguished by the absence of jointed thoracic limbs, which is of special interest in the case of those forms which live free upon leaves by prey (many larvæ of Syrphidæ); but with regard to the structure of the head, the armature of jaws, and the development of the tracheal system, there are, as is well known, such important differences, that they have been successfully employed for the systematic division of the order into several suborders and sections. Nevertheless even here intermediate grades are not wanting between the different structural characters (witness the variable development of the first cephalic segment); nay, in Brauer's* opinion, the family Lonchopteridæ may possibly prove to be a perfect transitional group between the Orthorapha and Cyclorapha, so that the multifarious forms of the larvæ at least offer no veto against the unitariness of the stem of the Diptera. The same thing can also be said of the pupæ, which indeed likewise fall under two main types, but are so far brought together by Brauer's investigations, that these furnish a proof that the so-called "tun-pupæ" (obtected pupæ) show very different grades of structure, and in many of them the enveloping larva-skin bursts exactly as in the ordinary moulting, and consequently is to be referred simply to a delayed moulting at the close of the larval period. In the latter case, moreover, if the appendages of the segments of the body are not so closely attached to each other and to the body as in the naked and consequently less protected and more easily injured "mummy-pupæ," no important objection against the natural relationship of the two groups can be derived from this circumstance, which evidently results from

* F. Brauer, 'Die Zweiflügler des Kais. Museums in Wien,' p. 9 (Vienna, 1883); also in the Denkschr. d. math.-naturwiss. Klasse d. k.-k. Akad. d. Wiss. Bd. xlvii.

altered condition. The "mummy-pupæ," however, show many differences among themselves with regard to the closer or looser appression of the appendages of the body, as may be demonstrated by a comparison of the pupæ of the Asilidæ, which rest in the ground, and those of *Tipulæ* which live in the water.

Of anatomical peculiarities of the Diptera especial mention must be made of the "sucking-stomach," which is always present, as also of the large thoracic salivary glands, the efferent ducts of which, wherever the buccal organs perform any function, unite into an unpaired closed canal, which, running along in the cavity of the hypopharynx, opens at its extremity. The testes are almost always two; the Malpighian vessels almost as regularly four. As regards the tracheal system, the constant absence of the first thoracic stigma and the small number of abdominal stigmata are to be noticed; while the nervous system, as is well known, shows all possible forms of development, from the most extreme concentration to a very considerable segmentation of the ganglionic chain.

If we turn from this brief account of the Dipterous type to the characters of the Pulicidæ, we must admit, in the first place, that in a whole series of points of comparison an agreement between the Diptera and the Fleas can be demonstrated. Like the Diptera, the Fleas have a suctorial buccal apparatus, a perfect metamorphosis, and footless larvæ; as in them also the tarsi are five-jointed, there are four Malpighian vessels, and one pair of testes. But, as has already been indicated at page 38, we could only ascribe decisive weight to this agreement if all these characters were peculiar to the Dipterous stem alone, and if at the same time, by more detailed comparison, real tenable parallels could be drawn between the different parts of the organs, as between the different stages of development. This, however, is by no means the case. The number of Malpighian vessels and of testes recurs in the same way in the Rhynchota, and therefore proves no more in favour of the relationship between the Fleas and the Diptera than the number of the tarsal joints or the annulation of the terminal knob of the antennæ, which may be recognized in all possible groups of insects. At the first glance more importance seems to attach to the agreement of the two groups in the larval state, which in fact goes so far, that Brauer* has no hesitation about arranging the larva of the flea in his group of orthoraphal eucephalous Dipterous larvæ. In opposition to

* Brauer, "Kurze Charakteristik der Dipterenlarven," in Verh. k.-k. zool.-bot. Ges. in Wien, 1869, p. 846.

this, however, we must not forget that maggot-like larvæ also occur in groups far removed from the Fly-type, in Hymenoptera and Beetles, and therefore cannot possibly be of decisive importance in judging of relations of affinity; as also, on the other hand, that the pupa of the Fleas with its quite separate limbs differs so much at least from the general type of the mummy-pupæ, that from this very fact it has been attempted to set up a relationship of the Fleas to the Hymenoptera *. Hence the point of the question how far the analogous characters in Diptera and Pulicidæ depend upon true phylogenetic affinity would have to be sought in the investigation whether the construction of the sucking-apparatus is carried out in both cases on the same plan, *i. e.* with the same employment of homologous parts. That it is only from this discussion and from that as to the structure of the thorax and its appendages that a real decision of the question before us can be arrived at, may indeed be deduced from the consideration that in these organs we find the only characters which, on the one hand, are confined to the order Diptera, and, on the other, may be traced throughout their whole series of forms, and therefore must be regarded *κατ' ἐξοχὴν* as typical.

The structure of the buccal apparatus of the Pulicidæ has been very frequently discussed without the question of its relationship to the sucking-apparatus of other groups of insects having as yet been solved. Thus to cite only a few:—Dugès † thinks that the proboscis of the flea may be placed side by side with that of the Tabanidæ, but also finds resemblances to the Hippoboscidæ and Apidæ. L. Landois ‡ suggests a resemblance of the mouth-apparatus of the Pulicidæ to the rostrum of the Hemiptera; while Taschenberg §, again, thinks he recognizes the Dipterous type, and especially calls attention to the presence of a "tongue" as the most characteristic part of the mouth of a fly. This extraordinary diversity of opinions is principally to be ascribed to the uncertainty of the interpretation of this very "tongue" of Taschenberg's. The mandibles, maxillæ, and labium have long since been recognized with certainty; but the unpaired piercer" (to express myself neutrally) has been referred to as the labrum (Westwood, Haller, Bonnet), as the hypo-

* As by Dugès, in his "Recherches sur les charactères zoologiques du genre *Pulex*," in Ann. Sci. Nat. tome xxvii. p. 157.

† *Loc. cit.* p. 151.

‡ L. Landois, "Anatomie des Hundeflohes," in Nova Acta Acad. Leop.-Car. 1866, p. 56.

§ *Loc. cit.* p. 41.

pharynx (Gerstfeldt), as the epipharynx (Karsten), and lastly, as already mentioned, as the "tongue" (Savigny, Taschenberg), and therefore all serious homologizing must have been prevented, the more, as even the real components of the sucking-tube were not made out with certainty.

In figs. 10 and 13 I give two transverse sections through the anterior part of the Pulicid proboscis. Fig. 10 represents a section from *Pulex irritans*; fig. 13 a similar section, but nearer the base of the proboscis, from *Sarcopsylla penetrans**. The sections show at once that the structure of the sucking-tube in the two most distant groups of the Pulicidæ is quite accordant. In both cases it is the mandibles (*md*), which, in conjunction with the "unpaired piercer," form the true food-canal; embracing the latter above and laterally, they join firmly together in the median line below. A glance of comparison at figs. 1–3 shows that this "unpaired piercer" is hollowed into a groove on the underside exactly in the same way as the *labrum* of the Diptera, and that to begin with there is no hypopharynx, but at the utmost perhaps an epipharynx. But if we trace the further course of this structure by the aid of longitudinal and transverse sections it is easily seen that its upper covering immediately after its entrance into the capsule of the head is in chitinous union with the upper margin of the arch of the head, while the inferior plate, *i. e.* the one which immediately forms half the sucking-channel, passes continuously into the chitinous covering-wall of the pharynx. Consequently we find in the organ in question precisely the same conditions as in the labrum of the Diptera, and there is no doubt at all that we have to do here with a true labrum. A connexion of this with the labium by means of a strongly chitinized, brown uniting piece, as asserted by Dugès (*l. c.* p. 150), really has no existence at all†, and this removes the last possibility of regarding this structure as a "tongue," *i. e.* as an extension or appendage of the labium.

The interpretation of the "unpaired piercer," as labrum, being thus established beyond a doubt, the comparison of the proboscis of the flea with that of the Diptera can present no further difficulties. The employment of the labrum (*lr*) as the unpaired covering lamella of the food-canal is apparently the same in both groups. But it is otherwise with the other components of the sucking-tube. In place of the horizontally-

* The material was kindly sent to me from Assumption by my honoured colleague Dr. H. Töppen.

† This chitinous piece rather forms the lever for moving the mandible, as will be shown elsewhere.

placed mandibles of the Tabanidæ and Culicidæ, which, as is proved by those Diptera which do not pierce, are only secondarily implicated in the closure of the sucking-canal, we see in the Pulicidæ the vertically-placed mandibles, bent in towards each other laterally, appear as integral parts of that tube—a different inferior closure, such as exists in the hypopharynx throughout the whole group of the Diptera, being here entirely deficient. This absence of the hypopharynx, which, as is clear from what has been said, has as its consequence a totally different importance of the mandibles, and consequently a perfectly peculiar type of sucking-tube*, proves in like manner of importance as regards the discharge of the salivary glands. The unpaired salivary duct in the lumen of the hypopharynx is replaced in the Pulicidæ by paired extremely fine half-tubes (fig. 13, *s*), each of which, running along the inner side of a mandible, may be traced from the basal part of the latter as a closed duct into the interior of the head, and, further, as far as the thoracic salivary gland †.

Equally great differences in their arrangement and physiological importance may be demonstrated by a comparison of the other constituents of the proboscis of the flea with the homologous organs of the Diptera. A labium unpaired throughout its whole length, and at the utmost furnished at its apex with one-jointed terminal lobes, occurs nowhere among the Pulicidæ, although something of the kind was formerly ascribed to *Sarcopsylla*. The labium of *Sarcopsylla* at least presents (as fig. 8 may show) a biarticulation of the "palpi," even with an indication of further segmentation, so that in this point also the unity of the Pulicide group appears. This difference of the segmentation of the labium in Diptera and Fleas, with which a typical difference in the relative length of the unpaired basal part to the paired section to be regarded as palpi, goes hand in hand, can, however, hardly be so highly estimated in its phylogenetic significance as the further fact that the labium of the Diptera shows quite a different attachment to the head, and so has quite a different physiological value from that of the Pulicidæ. In the former it generally attaches itself by its gradually widening base to a more or

* Particular attention may here be directed to the two peculiar lateral lamellæ of the labium, which apparently, by their elasticity, force the upper parts of the mandibles asunder, and thus bring about a closer apposition of their lower parts.

† Kraft and Landois believe that they have demonstrated an opening of the thoracic salivary glands into the œsophagus not far from the region of the neck (see Landois, *l. c.* p. 18).

less developed cephalic cone, with the upper lateral parts of which it is connected, and so is enabled from the base onwards to form that sheath of the delicate piercing apparatus (the two pairs of jaws as well as the labrum) which often arches together above so as to constitute almost a closed canal. In the Fleas, on the contrary, there is no such union of the labium with the lateral or upper parts of the head; it simply articulates with a firm brown chitinous piece (fig. 9, *c h*) in the median line of the lower surface of the head, and this union, as is well known, is frequently so loose that it is difficult to obtain *Sarcopsyllæ*, for example, with the labium preserved *. Hence, in its basal part, it does not form the sheath for the piercing-apparatus, but shows only a comparatively shallow groove (fig. 15), which only in the anterior section of the proboscis, when the stem of the labium has become cleft into the paired palpi, becomes developed, at least in *Pulex*, into two flaps, embracing the piercing-organ at the sides (fig. 10, *l p*). But to make up for the deficient protection of the basal part of the sucking-tube (and in this we have a fundamental deviation from the type of the Diptera) the maxillæ hava come in, originating as two broad plates from the whole length of the side of the head, and taking here, not only the constituents of the piercing-apparatus, but also the base of the labium, under their protection, as shown by fig. 15 in *Pulex*.

We seek in vain for analogies to all these characters among the Diptera, and we may therefore be justified in asserting that all the parts of the Pulicide proboscis (with the sole exception perhaps of the labrum) differ so much in position and employment from the homologous parts in the Diptera, that we cannot well speak of direct phylogenetic relations between the two types of proboscis.

We arrive at precisely similar conclusions as to the relationship of the Pulicidæ and Diptera when we take into consideration the second group of characters peculiar to the Diptera, which appear in *the structure of the thorax and its dorsal appendages*. Instead of the always freely movable head of the Diptera, we find a broad union of it with the prothorax in the Pulicidæ; instead of the compact thorax with its scutellum, which is so characteristic even of the wingless Pupipara, we have three sharply separated thoracic segments, without a trace of any such dorsal mesothoracic process; and instead of the pair of wings and the halteres, the latter of which are aborted only in the most extreme cases of parasitism,

* Even in recent handbooks we may find the statement that the labium of *Sarcopsylla* is indistinct.

there is *nothing*, absolutely nothing, that could lead us to conclude that the Fleas were formerly in possession of any such organs. Even the marked tripartite condition of the thorax ought *à priori* to have banished the idea of rudimentary wings; nevertheless the older authors (Kirby, Dugès, &c.) have fallen into the serious error of regarding separated lateral margins of the thoracic segments as such. But these "processes of the pleuræ," as Taschenberg * among others has conclusively proved, have nothing at all to do with wing-rudiments, and are to be regarded as characteristic structures *sui generis*. When Taschenberg therefore for this reason declares the generally-employed denomination of "Aphaniptera," founded upon this erroneous conception, to be inadmissible, we can only agree with him. It is only by giving up this name that we can seriously hope that the deeply rooted notion of the "Diptères sans ailes," as Strauss-Durckheim called the Fleas, will be completely suppressed.

The wide gap which exists precisely in the most important characters between the Pulicidæ and the Diptera must have been made sufficiently evident by the preceding remarks. That it is also expressed in other systems of organs than those hitherto considered may therefore only be briefly indicated. The sucking-stomach, which apparently is met with in all groups of Diptera, is entirely wanting in the Pulicidæ; while, on the other hand, the proventriculus beset with numerous chitinous spines of the latter has no analogy among the Diptera. The sucking-mechanism of the pharynx or of the so-called "fulcrum" of the Diptera is formed by a single powerful pair of muscles; in the Fleas, on the contrary (as in the Rhynchota), a whole series of separate pairs of muscles (which, however, are interpreted by Landois as flexors and retractors of the labrum) are present for this function. Lastly, the presence of a stigma in the prothorax of the Fleas indicates more profound differences in the tracheal system; while as regards the simple ocelli of the Pulicidæ and the deep lateral pits of the head, we may find analogous phenomena among the Rhynchota, but not among the Diptera.

After all this the Fleas cannot well remain in the order Diptera. There remains then the investigation of the question whether they show near relations to any of the other groups of insects. Hymenoptera and Orthoptera, of which earlier authors have thought in this connexion, cannot well come into the question in the present state of our knowledge, as it would be opposed to all rational system to assert a rela-

* *Loc. cit.* p. 21.

tionship of the Fleas to the Hymenoptera upon the sole accordance of the pupæ, or to the Orthoptera upon the segmentation of the thorax. The order Lepidoptera also cannot agree in a single one of the more important characters with the Pulicidæ, and thus there remains only the group Rhynchota for serious comparison. As a matter of course, considering the fundamental difference of development between Pulicidæ and Rhynchota, we can hardly expect to find real intimate relations between the two groups, at least not so close as we must postulate for forms of one and the same order; nevertheless I think I may indicate some points of view which deserve to be well considered in judging of the phylogenetic connexion between Fleas and Rhynchota.

In the first place there can be no doubt that the order Rhynchota does not even approximately present a unitary type in the same degree as that of the Diptera. We find united in it animals with suctorial and masticating buccal apparatus, with perfect, imperfect, and without metamorphosis. The head is sometimes freely movable, sometimes attached by a broad surface to the prothorax. The thorax, so very uniformly constructed in the Diptera, shows all possible stages of structure, from the enormous development of the separated prothorax in Scutata and Membracina, to the compact thorax showing scarcely an indication of segmentation of the Pediculina, or that of many Mallophaga more or less sharply divided into three distinct segments; and like the thorax itself, its dorsal appendages also present no unity of type. With such polymorphism of almost all organs it is easily intelligible that we should be able to find in this Protean group analogies for a whole series of characters of the Pulicidæ. Thus the segmentation and winglessness of the thorax in the Fleas may be without difficulty placed side by side with the similar conditions among the Mallophaga, which, at the same time, present examples of the antennary pits of the head already mentioned. The absence of facetted eyes in Pulicidæ agrees with what occurs in Coccidæ, Pediculinæ, and Mallophaga, the pupa enclosed in a cocoon unites them with the Coccidæ; the absence of sucking-stomach and the number of the Malpighian vessels and testes are even common to them and to all forms of Rhynchota.

For the reasons above given, however, we must not ascribe a serious significance to all these agreements unless the Rhynchotan type sought for finds expression at least in the last of the characters to be discussed, those of the buccal apparatus, and shows near relations to the homologous organs of the Fleas. According to the present state of our knowledge it cannot well be maintained that there is a clear unitariness of structure in the buccal organs of the Rhynchota, as, at any rate among the Aptera (the Pediculina and Mallophaga), conditions occur which depart widely from those of the more highly organized groups. But as the arguments upon this point are not yet closed and I have made no investigations upon these lower forms, we must content ourselves with examining at least the sucking-apparatus of the Hemiptera and Cicadæ in search of any agreement with the proboscis of the Fleas that may exist. With regard to the arrangement of the parts of the mouth in these higher groups of the Rhynchota, I have already published some statements in a previous note *, and these observations have since been confirmed and extended by Geise †. According to these the true sucking-tube of the proboscis is formed by the two maxillæ closing laterally against each other into a double tube, while the mandibles are placed alongside of this tube as lateral piercing-setæ. From more recent investigations I do not hesitate to declare this view ‡ so far erroneous that it is not the *maxillæ* but rather the *mandibles* that interlock in the median line to form the sucking-tube (see figs. 11, 14). I am led to this changed interpretation of the two pairs of jaws in the first place by the fact that in transverse sections through the head the *lateral* setæ finally come to be the lower ones, as, indeed, Geise correctly shows in his figs. 25 and 31. Secondly, I think that in the Cicadæ I have found distinct traces of basal joints of the maxillæ connected with the *outer* setæ. Fig. 12 shows the lower part of the face of a large tropical Cicada. On each side of the broad labrum (*lr*) there is here an oblong plate (*pl*), which terminates almost in the middle line beneath the labrum in a blunt hairy tubercle and a peculiar whip-like appendage (fig. 6, *f*). If this structure be prepared out of the head, a connexion, certainly only by articulation, with the lateral piercing setæ may be easily demonstrated, for protrusion and retraction of which not only the chitinous sinews (fig. 6, *sp* and *sr*), but also the corresponding muscles (fig. 6, *pm* and *rm*) are attached to this chitinous piece. If this interpretation of the chitinous piece occurring in all Cicadæ, Fulgorinæ, &c., as the basal part of a jaw, perhaps even with palpiform appendages, be correct, this must, of

* Zool. Anzeiger, 1882, p. 574.

† Geise, 'Die Mundtheile der Rhynchoten' (Bonn, 1883).

‡ On my part this resulted merely from what I now believe to be a wholly unjustified homologizing with the buccal organs of the Lepidoptera, the sucking-tube of which is undoubtedly formed of the maxillæ (see also Kirbach, Zool. Anz. 1883, p. 553).

course, be a maxilla, and thus the composition of the sucking tube out of the two mandibles would be finally decided. Bu then we should at once be enabled, in *one* point, to carry ou a corresponding comparison between the buccal organs of the Pulicidæ and Rhynchota, inasmuch as we need only suppose the labrum of the latter, which is indeed often enough developed into a long, slender, stylet-like organ, to sink from above between the mandibles*, in order to arrive at conditions which might perfectly well be placed side by side with those occurring in Pulicidæ (compare fig. 11 with fig. 15). It appears further that upon the basis of my conception a connexion might be established between the modes of discharge of the saliva in the Pulicidæ and Rhynchota, if we assume that the paired half-grooves along the inner side of the mandibles of the Pulicidæ (fig. 13, *s*) have coalesced in consequence of the changed adhesion of these jaws, caused by the emergence of the labrum, as a constituent of the sucking-tube, into an unpaired efferent canal (figs. 11 and 14, *s*). The variable part taken by the two mandibles in Hemiptera and Cicadæ (see fig. 14) in the formation of this salivary tube would come in support of this hypothesis. Among the Rhynchota, as is well known, a hypopharynx is not developed as a separate organ, or only as a rudiment (in Cicadæ), so that in this circumstance also a parallelism between Pulicidæ and Bugs may be found.

The *labium* of the Rhynchota consists of four consecutive cylindrical joints furnished with a deep longitudinal groove along the upper surface. It has been said that it is destitute of palpi, but I think that this mode of expression is not correct. A labium divided into four or five successive rings is in complete contradiction to the plan of the organ deduced from the consideration of the masticating mouth. But notwithstanding Geise's assertion to the contrary (*l. c.* p. 11), there is nothing to prevent our regarding the cylindrical and often much more voluminous basal part of the labium as the submentum and mentum, as a direct continuation of which arise the multiarticulate palpi fused together in the median line. That there is really an amalgamation in the terminal joint of the labium is rendered probable by the circumstance that both in the Hemiptera and in Cicadæ a pretty

* Geise asserts something of the kind when he represents the labrum in *Corixa* and *Sigara* as taking part with the constituents of the sucking-tube (*l. c.* p. 53, fig. 29); unfortunately I must reject this assertion—welcome as it would be to me for the homology attempted above—as positively erroneous.

considerable notch appears at the apex*, although the side lobes thus produced are not jointed off from the unpaired piece in the same way as is usually the case, with the labella of the Diptera for example. But if this conception of the structure of the labium of the Rhynchota be correct, a comparison of it with that of the Pulicidæ presents no difficulties. A fusion of the longitudinal fissure of the labium of *Sarcopsylla* (fig. 8), for example, nearly to the apex, would essentially realize for us the conditions existing in Rhynchota (compare the labium of Cicada in fig. 5). And with this apparent equivalence of the parts an approximately similar physiological application of them would be associated.

It has already been pointed out that the labium of the Pulicidæ has undertaken the guidance of the sucking-tube only in its distal and not in its proximal part. But exactly the same thing may be asserted of the labium of the Rhynchota, which in the basal section of the rostrum shows an effacement of the dorsal furrow and decidedly turns downwards, and thus devolves the guidance of the sucking-canal and of the piercing setæ entirely upon the labrum. In the latter circumstance, indeed, there is an essential difference between the proboscis of the Fleas and that of the Rhynchota, as in the former the labrum, which has become one of the constituents of the sucking-tube, cannot possibly be employed to envelop the whole apparatus. But precisely this different application of the labrum renders intelligible a further fundamental difference between the two types of proboscis, which must be found in the physiological application of the maxillæ. In the sucking-tube of the Rhynchota, which, under the double guidance of the labium and labrum, is sufficiently enveloped and protected throughout its whole length, the maxillæ might, without damage, be brought in to complete the true piercing-apparatus; they have become long thin structures, destitute of palpi, flanking the sucking-tube. In the Pulicidæ, on the contrary, in which the basal section of the sucking-tube, in consequence of the peculiar employment of the labrum, was destitute of an envelope, the maxillæ, developed into broad plates (figs. 4 and 7 and 15, *m*), had this important function of protection transferred to them. That under such a change of function the palpi

* The section across the tip of the rostrum of *Notonecta* (fig. 14) shows the labium as consisting of two perfectly separate parts. Geise's statement that in *Corixa* the third and fourth joints of the labium are completely cleft, depends, according to my investigations, upon an erroneous interpretation of the conditions coming into view at the tip of the rostrum.

also came to full development and importance, can hardly be regarded as a serious obstacle to the homology here attempted.

The preceding indications will suffice to prove that in fact, without any great violence to the data given, a certain parallel may be drawn between the buccal organs of the Fleas and those of the higher Rhynchota, and that this comparison is at least far easier to carry out than that between the Pulicidæ and the Diptera. If we bring the other agreements and differences of the three groups in question into the account, the result must be a phylogenetic alliance, although a distant one, of the Fleas with the Rhynchota rather than with the Diptera. But I repeat that the demonstrated relations certainly by no means justify a union of the two groups. The only possibility that presents itself is therefore to place the Pulicidæ as an equivalent order Siphonaptera * side by side with the two most nearly allied orders.

The entire series of insects with suctorial mouth-organs would consequently have to be divided in the first place into two groups, one of which (Hymenoptera, Lepidoptera) is characterized by having the lower parts of the mouth, maxillæ, and labium employed in the formation of a sucking-apparatus, while in the other, on the contrary, it is almost exclusively the upper parts (labrum and mandibles) that are implicated in the formation of the true food-canal. This latter group would include the three orders Diptera, Siphonaptera, and Rhynchota, which I may, in conclusion, briefly characterize as follows:—

1. Diptera. Insects with perfect metamorphosis. Head free, with facetted eyes. Sucking-tube formed by a dorsal and a ventral half-channel (labrum and hypopharynx), more or less enclosed throughout its length by the labium, which is bent up like a sheath and furnished with uniarticulate apical palpi. Mandibles deficient or styletiform, pushing in between the labrum and hypopharynx. Maxillæ, when present, with palpi. Salivary efferent duct an unpaired closed canal in the interior of the hypopharynx. A "sucking-stomach." Thoracic segments amalgamated, usually with a pair of wings and a pair of halteres.

2. Siphonaptera. Insects with perfect metamorphosis. Head attached to the thorax by a wide surface, without facetted eyes. Buccal organs suctorial. Sucking-tube formed

* As the name "Aphaniptera" is inadmissible for reasons already given, and that adopted by Taschenberg, "Suctoria," has already been employed twice, for a group of Cirripedes and for the Acinetæ, I think it best to fall back upon Latreille's name "Siphonaptera."

by a dorsal and two lateral channels (labrum and mandibles), its anterior section only more or less enclosed laterally by the multiarticulate terminal palpi of the labium, and at the base, besides the latter, by the lamelliform palpigerous maxillæ. Salivary efferent ducts paired, developed as a channel along the inner surface of the mandibles. No "sucking-stomach." Thoracic segments free, without wings and halteres, with pleural processes upon the last two segments.

3. Rhynchota. Insects usually with imperfect metamorphosis. Head free or broadly united to the thorax, with or without facetted eyes. Buccal organs usually suctorial. Sucking-tube (in the higher groups) composed of two lateral half-channels (the mandibles), only in the anterior portion enclosed by the labium and its apical multiarticulate palpi, which are united nearly to the apex; at the base by the labrum. Maxillæ styliform, without palpi, applied laterally to the mandibles in the channel of the labium or the labrum. Salivary efferent duct unpaired, formed by two half-channels of the mandibles closing together from the sides. No "sucking-stomach." Thoracic segments free or amalgamated. Four, two, or no wings; no halteres.

EXPLANATION OF PLATE III.

The letters in all the figures refer to the same parts:—*l r*, labrum; *m d*, mandibles; *m*, maxillæ; *m t*, maxillary palpi; *l*, labium; *l p*, labial palpi; *h*, hypopharynx; *n*, food-canal; *s*, salivary duct.

Fig. 1. Transverse section through the proboscis of *Tabanus*, sp., anterior third.

Fig. 2. Transverse section through the proboscis of *Melophagus ovinus*, middle.

Fig. 3. Transverse section through the proboscis of *Culex pipiens* ♀, middle.

Fig. 4. Maxilla of *Sarcopsylla penetrans*, side view.

Fig. 5. Labium of *Cicada*, sp., side view.

Fig. 6. Lower part of the maxilla of *Cicada* sp., and its union with a lamelliform appendage (*pl*) of the fore part of the head. *f*, whip-like process of the plate; *p m*, protrusor; *r m*, retractor of the maxilla; *s p* and *s r*, the sinews belonging to them. At *x* the sinew of the protrusor articulates with a chitinous rod which is perpendicular to the surface of the plate, and therefore does not appear distinctly in the figure.

Fig. 7. Maxilla of *Pulex irritans*.

Fig. 8. Labium of *Sarcopsylla penetrans* from above.

Fig. 9. Labium of *Pulex irritans*, side view. *ch*, basal chitinous piece.

Fig. 10. Transverse section through the proboscis of *Pulex irritans*, anterior third.

Fig. 11. Transverse section through the rostrum of *Notonecta glauca*, basal third.

Fig. 12. Front view of the head of *Cicada* sp. *pl*, plates with which the maxillæ articulate.
Fig. 13. Transverse section through the proboscis of *Sarcopsylla penetrans*, middle.
Fig. 14. Transverse section through the rostrum of *Notonecta glauca*, apex.
Fig. 15. Transverse section through the proboscis of *Pulex irritans*, base.

VI.—*New Investigations on the Development of the Viviparous Aphides.* By Dr. OTTO ZACHARIAS *.

SINCE the appearance of Metschnikoff's 'Embryologische Studien an Insecten' (1866) the development of the embryo of the viviparous Aphides has not again been made the subject of a monographic investigation. What the Russian author established with regard to the mode of development of the "pseudova" of *Aphis Rosæ* and *A. Pelargonii* passes pretty generally for all that is observable at present. Metschnikoff's description of the development of Aphides (at least in its fundamental features) is regarded as a "rocher de bronze," which presents no point of attack for an incisive criticism. This, however, is not the case, and I will, in a memoir that will appear very shortly, furnish the proof that Metschnikoff's description of the *first* developmental stages (as far as the formation of the S-shaped germinal streak, and even somewhat later) by no means agrees with the facts. For the subsequent stages I have also obtained quite different results of investigation, which I shall venture to summarize at the conclusion of this preliminary note.

The observation of the embryonic development of the viviparous Aphides is for many reasons a difficult matter. Besides the minuteness and delicacy of the objects with which we have to do, there is a third condition which causes many obstacles to the investigation, namely the clearness and strong refractive power of the protoplasmic contents of the egg. If in the case of the eggs of many other insects we have to contend with the obscurity of their yelk, it is in the Aphides the crystal clearness of the latter which frequently acts very prejudicially: prejudicially, inasmuch as under the circumstances indicated the upper half of the egg constantly acts upon the lower half (or *vice versâ*), like a lens with a very short focus, and not only enlarges but also distorts those

* Translated from the 'Zoologischer Anzeiger,' no. 168, May 26, 1884, pp. 292–296.

parts of the embryo which lie in a plane passing through the middle of the egg parallel to the object-slide. This opens up a rich source of illusions for those who come uncritically to the investigation; but for those who are aware of the optical behaviour of the pseudovitellus there arises the unconditional necessity of correcting every surface-picture observed by the side view corresponding to it, and, if possible, by the other surface-picture (that directly opposite to the first). In the former case the embryo must be turned 90°, in the latter 180°.

Without this method of rolling, already mentioned by Harting in his well-known work on the microscope, it is not possible to make out the earliest development of the *Aphis*-embryo. Of course it is not easy to practise the method referred to, and many a fine preparation is sacrificed by clumsy handling of the wire which is employed in producing the rotation. In my memoir I will describe in detail the rolling method as it should be constantly employed in the more delicate investigations in insect embryology.

I will now briefly indicate in what principal points the results of my investigations differ from those obtained by the distinguished Russian naturalist.

The pseudovum possesses no chorion, but only a vitelline membrane, Huxley's "pseudo-vitelline membrane." This encloses the whole contents of the egg, which, at a certain early period (as Leuckart first remarked *), shows a distinction between peripheral and central cells. We read also in Huxley as follows:—" They [the pseudova] exhibit a central darkish matter surrounded by a clear cortex." Upon this point the simplest observation gives clear information. The development of the embryo now starts from the " clear cortex," the *blastoderm*, which forms a multilamellar vesicle, and, indeed, in this way, that at its lower pole (*i. e.* that turned towards the vagina) a thickening is formed, from which the germinal streak grows forth *laterally* (and near to the inner wall of the blastoderm) in the form of a small thick tongue. The yelk at this time contracts strongly, and places itself, as a rounded mass, also at the inferior pole of the germinal vesicle. This is the profile view, so to speak. If we now roll the pseudovum through 90° we obtain a view *en face*; and Metschnikoff appears to have this alone in his eye when he speaks of a germinal and a vitelline " hill," the appearance of which characterizes the earliest embryonic stage of the viviparous Aphides. In the surface-view our glance of course falls first upon the broad side of the tongue, which now looks like a

* 'Zur Kenntniss des Generationswechsels und der Parthenogenese bei den Insekten' (1858), p. 20.

"hill," and behind it rises the contracted yelk, and also appears like a hill. This therefore explains how Metschnikoff came to the notion of a germinal and vitelline hill. But such a notion is not justified by the facts, and still less that of a special *genital* hill from which the reproductive organs are to originate. It is moreover quite incomprehensible that so practised an observer as Metschnikoff even then was could overlook the fact that the tongue of the germinal streak growing freely into the cavity of the blastoderm immediately shows a deep groove in its median line, becomes rounded off on both sides throughout its whole length, and thus produces two distinctly marked *germinal pads*. Metschnikoff, on the contrary, repeatedly remarks that the embryo in its early stage shows *no trace* of such pads *.

This negative judgment I can only explain by the fact that Metschnikoff apparently does not practise the "method of rolling," and therefore did not get to see the different aspects of the embryo. In this opinion I am only strengthened by the examination of his figures 16, 17, 18, 19, and 20 (pls. xxviii. and xxix.), as also by the reading of the text relating to them (pp. 444–448). Every one who comes fresh and unprejudiced to the investigation of the development of the Aphides will make the surprising observation that the developmental processes which finally lead to the formation of the S-shaped germinal streak are not performed in the plane in which Metschnikoff places them in his figures, but in one standing directly perpendicular to it. In my memoir I shall produce the exact proof of this, and also furnish the requisite figures which I have found to be verified in hundreds of preparations.

As regards the S-shaped germinal streak, which is well known to all investigators of Aphides, the inferior curve of this letter (which is turned to the left) represents the *cephalic hood*, the same structure, it may be said in passing, which Huxley, entirely mistaking the relative position of the Aphis-germ, characterized as the "abdominal hood." The upper curve (turned to the right) represents the rudiment of the abdomen, and the intermediate part contains the material for the formation of the head and thorax.

The *limbs* take their origin from a special superficial layer, the so-called *limb-plate* ("Extremitätenplatte"), as to the origin of which Metschnikoff has not got at the truth either in *Simulia* and *Corixa* or in *Aphis Rosæ* (see his paper, *loc. cit.* pp. 400, 427, and 448). For the Aphides I have

* Zeitschr. f. wiss. Zool. Bd. xvi. (1866), pp. 448 and 450.

succeeded in proving that the so-called "Extremitätenschicht" is a part of the blastoderm which at a very early period enters into an intimate fusion with the true germinal streak. The details of this are treated of in my memoir.

Besides the two *vertex-plates* (Huxley's "procephalic lobes") which originate from the primitive lateral plates, we have also to distinguish in Aphis-embryos a *median plate*, which is produced from the ventral part of the cephalic hood. I would name it the *mandibular plate*, as the two mandibles are formed from it.

The first and second *maxillæ* originate from that part of the limb-plate which overlies the procephalic portion of the germinal streak, or is amalgamated with the latter. The arrangement of the three pairs of buccal organs is of such a kind that a hexagon is formed, the outer angles of which are constituted by the first maxillæ.

Later on the rudiments of the mandibles and first maxillæ are enclosed in the depth of the head, and from them originate the "*retort-shaped bodies*" (of Metschnikoff), which secrete the chitinous stylets of the rostrum. In the mature embryo we perceive two such bodies *on each side*, not one only, as Metschnikoff's figures show. *By the demonstration that it really is by the transformation of the mandibles and maxillæ that the retort-shaped bodies are produced, the parts of the mouth of the Aphides are first brought into homology with the corresponding organs in other insects.*

According to Metschnikoff, as is well known, the mandibles and first maxillæ are completely retrograded, and the "bodies" secreting the piercing setæ originate quite newly. This was *à priori* very improbable, and observation gives quite another result. By carefully crushing half-mature embryos the actual conditions may often be very beautifully brought into view.

Witlaczil, who has treated of the anatomy of the Aphides in much detail in a recent memoir *, gives a very full description of the structure of the retort-shaped bodies as studied by him by means of sagittal and transverse sections through fully-developed animals.

For orientation in many difficult points of the development of Aphides, *e. g.* as to the question whether or not the *Malpighian vessels* are present in these animals at any time, I have turned to the allied group of the Coccidæ, and not without success. Thus I distinctly saw in *Coccus hesperidum* that the *brown* masses of substance corresponding to the secondary vitellus in *Aphis Rosæ* arrange themselves very

* 'Zur Anatomie der Aphiden' (Wien, 1882).

early in the form of two long cords, which open close together into the intestine in the region of the rectal section. According to this observation I do not hesitate to adopt Witlaczil's view, according to which the green cell-mass in the abdomen of the viviparous Aphides (which is likewise arranged into two cords) represents the Malpighian vessels of other insects. In a very pale Aphis-embryo I was able clearly to detect, besides the very distinctly marked dorsal vessel, the point of convergence of the two cords, but without distinctly seeing the point of discharge (as in *Coccus hesperidum*).

The egg of the viviparous Aphides, for which I have here and there, for convenience' sake, employed the antiquated term "pseudovum," therefore presents exceedingly interesting and very distinctly observable developmental processes, which cannot be sufficiently studied. In recent times Dr. Arnold Brass* (of Leipzig) and Dr. Ludwig Will† (of Rostock) have occupied themselves with the earliest stages of development. The last-mentioned gentleman has also already announced the publication of a work upon the later stages of the Aphis-embryo. In course of time many other workers will certainly have to be registered for this highly interesting subject.

VII.—*Notes on the South-Russian* Spongillidæ. By Dr. W. Dybowski ‡.

Dr. P. T. Stepanow, Professor of Zoology in the University of Charkow, has had the kindness to send me some specimens of the freshwater sponges for scientific investigation. The sponges preserved in the Museum of the above University and those collected by Prof. Stepanow himself are from the following localities :—

1. From the river Udy (a right affluent of the Siewiernyj Daniec), Gov. Charkow.
2. From Lake Lebiedin (Circle Lebiedin), Gov. Charkow.
3. From the river Kolomak (left affluent of the Worska, a branch of the Dnieper), Gov. Poltawa.

* "Das Ovarium und die ersten Entwicklungsstadien des Eies der viviparen Aphiden," in Zeitschr. f. Naturwiss. Bd. iv. (1882).

† "Zur Bildung des Eies und des Blastoderms bei den viviparen Aphiden," in Arbeiten des Zool. Instit. zu Würzburg, 1883, Heft 3.

‡ Translated by W. S. Dallas, F.L.S., from the 'Sitzungsberichte der Naturforscher-Gesellschaft bei der Universität Dorpat,' Bd. vi. pp. 507–515 (1884).

4. From the river Siewiernyj Daniec, Gov. Charkow.
5. From Lake Wielikoje (Circle Lebiedin), Gov. Charkow.

Offering my best thanks to the sender of these sponges, I now communicate the results of my investigations upon them.

These results are as follows. The Spongillæ of these five localities represent three species, namely:—

A. *Spongilla lacustris.*
B. *Meyenia* (*Ephydatia*) *fluviatilis.*
C. *Dosilia* (?) *Stepanowii*, n. sp.

The first two of these * I have only briefly described; but the third, as a form hitherto unknown to science, has received as accurate and detailed a description as possible.

Spongilla lacustris, Carter, occurs in very thin lamellæ, coating in spots or cones the leaves of *Acorus Calamus* and *Quercus* sp.; they are evidently quite young and undeveloped specimens, in which I have consequently found no gemmules. The skeleton-spicules are 0·224–0·130 millim. long, 0·010–0·002 millim. thick †. The size of the parenchyma-spicules varies between 0·050 and 0·060 millim. in length, and 0·002 and 0·004 millim. in thickness. These spicules perfectly agree with those described by me (*loc. cit.*).

Among the spicules such deformities frequently occur as I have already described and figured (*l. c.*); but among the most peculiar are the clavate and pin-shaped spicules, the heads of which are sometimes quite smooth and rounded, but sometimes variously misshaped, or furnished with small spines ‡.

Localities. Daniec, Kolomak.

The *Meyenia fluviatilis*, auct., agrees perfectly with that described by me (*l. c.* p. 13). I have before me four fragments of a large, fully developed sponge and a couple of smaller ones. In all numerous gemmules are present. The fragments belong to cushion-like sponges; the smaller sponges, on the contrary, are growing round a stem, 8 millim. thick, of *Arundo* sp.

Localities. Lake Lebiedin, river Udy.

* See Dybowski, "Studien über die Süsswasser-Schwämme des Russischen Reiches," in Mém. Acad. Sci. St. Pétersb. sér. 7, tome xxx. no. 10, p. 6, tab. i. figs. 4, 6, 7, and p. 13, tab. i. fig. 3, and tab. ii. fig. 9.

† In my memoir (*l. c.*) p. 10, column 1, line 4 of the measurements, 0·009 is erroneously printed instead of 0·002, and in column 3, line 6, 0·028 instead of 0·002.

‡ The figures necessary for the more ready intelligence of all the descriptions here given, I have prepared with the aid of a Hartnack's prism, and will publish them when opportunity serves.

Dosilia (?) *Stepanowii*, n. sp.

This Spongilla, from Lake Wielikoje, is of very peculiar interest. So far as I know, no form similar to our sponge has hitherto been described among the European Spongillidæ, at least, I have been unable to find any notice of it in the literature accessible to me; on the other hand, among the exotic (American and Asiatic) Spongillidæ, I find analogous, and, it seems to me, nearly allied forms.

The genus *Dosilia*, Gray*, which Carter† places in his "*Meyenia*," possesses two species—*Dosilia plumosa* (from Bombay) and *D. Baileyi* (from New York). The latter appears to me the form most nearly allied to our sponge‡.

To justify and support my opinion I will here give as accurate a description as possible of our sponge, and then place side by side the most prominent characters of the two (Russian and American) sponges, so as to facilitate for other authors the comparison of the two sponges with one another.

Description.—Of the sponge under consideration I have before me six small spirit-specimens, all of which are defective and do not enable us to form any definite notion of their form. They are chiefly shapeless masses, growing round various foreign bodies (such as leaves and stalks of grasses, fragments of bast, very thin twigs, and even quills of a small wing-feather). The specimens in spirit are pale tawny, and look not unlike soaked bread. The skeleton-spicules are long and slender acerates with acute ends, that is to say, they have the form of the spicules proper to the Spongillæ with smooth spicules in general; but they are somewhat smaller, their length being 0·200–0·104, and their thickness 0·065–0·004 millim. The surface of the skeleton-spicules is, however, not smooth, but furnished with very short, acute, and exceedingly scattered spines§.

* J. E. Gray, "Notes on the Arrangement of Sponges, with the Description of some new Genera," in Proc. Zool. Soc. Lond. 1867, pp. 550–553, pls. xxvii. & xxviii.

† Carter, "History and Classification of the known Species of *Spongilla*," in Ann. & Mag. Nat. Hist. ser. 5, vol. vii. (1881), pp. 78–107, pls. v. & vi.

‡ Neither of the two species mentioned is known to me by autopsy. I have drawn my conclusions as to the affinities of our sponge only from the statements in the literature, and must therefore for the present abstain from a certain and final decision.

§ The above-mentioned spines are so small and inconspicuous that they may very easily be overlooked. They are most conveniently observed with the light of an oil-lamp and with the objective no. 8. When they have once been observed they may quite easily be recognized with objective no. 4. The spines appear most distinctly at the periphery of the spicules.

The skeleton-spicules of the sponge under notice constitute, as it were, a transitional form between the smooth and the spiny Spongillid spicules*. The parenchyma-spicules are also remarkably peculiar and characteristic. They are small acerates, measuring 0·040–0·050 millim. in length and 0·025–0·010 millim. in thickness, and furnished with spines; in form they generally resemble those of *Spongilla lacustris*, but the form and arrangement of the spines are quite different from those in the spicules of the latter *Spongilla*. Here the spines occur in three different forms: the middle portion of the spicule is beset with long, obtuse, vertically projecting spines, but the two ends present small, pointed hooklets, while towards the middle of the spicule there exist pointed erect spines. The long straight spines of the middle section are frequently also covered with small acute spines; the free end of the spine is sometimes rounded off, sometimes truncated, and sometimes furnished with a knob or a T-shaped rod. The gemmules I have not been able to find, but I found in the parenchyma of the sponges numerous amphidisci.

The spindle-shaped amphidisci are very long; their dimensions are as follows:—

	millim.
Total length....................	0·040–0·028
Thickness of the shaft............	0·002–0·004
Diameter of the disk	0·012–0·010

The shaft is furnished on its surface with large perpendicular spines.

The two terminal disks (*disci*) are furnished at the margins with deep notches; the teeth thus formed have a perpendicular position.

The actual form of the disk, as well as the number of teeth on each disk, I have been unable to ascertain.

If we summarize the most important characters of our sponge and compare them with those of *Dosilia Baileyi*, it appears that the two sponges must belong to the same genus, but are specifically different.

These characters are as follows:—

Dosilia Baileyi, Carter (*l. c.* p. 95).

"Coating, surface smooth. Structure friable, crumbling. Skeleton-spicule curved, subfusiform, gradually sharp-pointed, smooth. Flesh-spicule minute, curved, fusiform, gradually sharp-pointed, covered with erect obtuse spines throughout, extremely small towards the extremities, and extremely long and perpendicular about the centre of the shaft. Statoblasts

* See Dybowski, *l. c.* tab. i. figs. 3 & 5.

globular; aperture infundibular; crust, which is thick and composed of granular cell-substance, charged with birotulate spicules consisting of a long, straight, sparsely spiniferous shaft whose spines are large, irregular in length, conical and perpendicular, terminated at each end by an umbonate disk of equal size, deeply but regularly denticulated, whose processes are claw-like and turned inwards, arranged perpendicularly, with one disk resting on the chitinous coat and the other forming part of the surface of the statoblast.

"*Locality*. New York. In a stream on the Canterbury Road, West Point."

Dosilia Stepanowii, n. sp.

Surrounding; surface smooth.

Skeleton-spicules long, pointed, and covered with small, acute, but scantily distributed spines.

Parenchyma-spicules small, pointed, and covered with spines. Spines in the middle section long, obtuse, and perpendicular; at the two ends small, acute, hook-like; towards the middle small, acute, perpendicular. Amphidisci spindle-shaped, their shaft long and furnished with a few large perpendicular spines.

The two terminal disks are toothed at the margins. The teeth have a perpendicular position.

Locality. Lake Wielikoje.

In conclusion, it may be mentioned that I found in the parenchyma of the Spongillidæ just investigated by me some siliceous corpuscles, which it seems to me may be small parenchyma, or coating spicules of still unknown Spongillidæ. From this I conclude that other unknown Spongillidæ must certainly occur in the waters of the Government of Charkow and of South Russia generally.

Would it not be advisable on the part of the University of Charkow to make a prize-problem of the investigation of the South-Russian Spongillidæ? It would be a very grateful theme for a pupil of that University, the solution of which might advance the knowledge of a group of animals which is still but little known not only in Russia but also in the rest of Europe.

Further, I may call attention to the fact that very numerous Diatoms and Algæ are present in the parenchyma of the Spongillidæ, so that these plants, otherwise so difficult to discover, are to be sought in the interior of these sponges.

Postscript.—The Spongilla from Lake Hertha (in the island of Rügen), kindly communicated to me by Dr. Braun of Dorpat, proves, from my investigation of it, to be a *Spon-*

gilla lacustris, auct. It agrees perfectly with the specimens of that species obtained from the Ludwinow estate (see Süssw.-Schw. d. Russ. Reiches, p. 6). This fact is of interest as furnishing a small contribution to the zoogeography of the Spongillæ, especially as, so far as I know, no Spongillæ were previously known from that locality.

VIII.—*On the Synonymy of some Heterocerous Lepidontera.* By Rudolph Rosenstock, B.A.

I incidentally discovered and noted the following synonyms while systematically studying the collection of Lepidoptera in the British Museum. They are for the most part redescriptions by the late Mr. Walker of species previously described either by himself or other authors.

1. Noctuites.

Poaphila congesta, *Walk.* Venezuela.	=	Anthophila erecta, *Walk.* San Domingo.
Remigia triangularis, *Walk.* N. India.	=	Toxocampa costimacula, *Walk.* Sylhet.

2. Pyralites.

Hypena disclusalis, *Walk.* S. Africa.	=	Hypena senialis, *Guén.* Central Africa.
Marimatha confisinalis, *Walk.* Loc. —— ?	=	Anthophila semipurpurea, *Walk.* Loc. —— ?
Pyralis dispansalis, *Walk.* San Domingo.	=	Carcha hersilialis, *Walk.* San Domingo.
Lepyrodes lepidalis, *Walk.* Ceylon, N. India. Stenia pipleisalis, *Walk.* Sierra Leone. Hymenia meridionalis, *Walk.* S. India.	=	Samea (*Guén.*) sidealis, *Walk.* Sierra Leone. (This is evidently an Old-World species of wide range.)
Botys hortalis, *Walk.* Bogota, Santarem.	=	Botys marialis, *Walk.* San Domingo.
—— strictalis, *Walk.* N. America. —— olliusalis, *Walk.* U. S. America. —— ofellusalis, *Walk.* Loc. —— ?	=	—— flavidalis, *Walk.* N. America.
—— philealis, *Walk.* Venezuela.	=	—— lycialis, *Walk.* San Domingo.
—— ænippialis, *Walk.* Bogota. —— codrusalis, *Walk.* Bogota.	=	—— dorisalis, *Walk.* Villa Nova.

Botys semizebralis, *Walk.* S. India.	=	Botys amyntusalis, *Walk.* Ceylon.
—— convectalis, *Walk.* S. India. —— suspicalis, *Walk.* Ceylon.	=	—— neoclesalis, *Walk.* Cape.
—— memmialis, *Walk.* Loc. ——?	=	—— campalis, *Walk.* Jamaica, San Domingo.
—— ogmiusalis, *Walk.* San Domingo.	=	—— gastralis, *Guén.* San Domingo.
—— cinctipedalis, *Walk.* Georgia.	=	—— oxydalis, *Guén.* U. S. America.
Ebulea heronalis, *Walk.* Honduras.	=	—— acastalis, *Guén.* Honduras.
Spilodes helvialis, *Walk.* U. S. America.	=	—— apertalis, *Guén.* N. America.
Botys gnomalis, *Walk.* San Domingo.	=	Omiodes humeralis ♀, *Guén.* San Domingo.
—— peleusalis, *Walk.* San Domingo.	=	—— —— ♂, *Guén.* San Domingo.
—— orontesalis, *Walk.* Ega, Venezuela.	=	—— simialis, *Guén.* Cayenne.

The following species placed by Walker under *Botys* possess the generic characters of Guénée's genus *Omiodes*, which appears to have a wide distribution :—

Botys ceresalis, *Walk.* San Domingo.	Botys orphnealis, *Walk.* Loc. ——?
—— jasonalis, *Walk.* San Domingo.	—— bianoralis, *Walk.* Japan.
—— helicitalis, *Walk.* San Domingo.	—— pharaxalis, *Walk.* Moreton Bay, Australia.
—— philetalis, *Walk.* Santarem.	

3. Geometrites.

Tephrina confiniaria, *Walk.* San Domingo.	=	Psamatodes nicetaria, *Guén.* San Domingo.

(Walker intimates the possible identity of these two species, Cat. xxiii. p. 971.)

Sterrha participata, *Walk.* Namaqua Land.	=	Sterrha plectaria, *Guén.* (Phal. pl. viii. fig. 7). S. Africa.
Aspilates proxantharia, *Walk.* S. Africa.	=	Aspilates occupata, *Walk.* S. Africa.
—— ? biferaria, *Walk.* S. Africa.	=	—— justaria, *Walk.* Namaqua Land.
Mergana bilineata, *Moore.* Darjiling.	=	Sarcinodes carnearia, *Guén.* India.

The genera *Mergana* and *Auxima* of Walker are synonymous with *Sarcinodes*, Guénée's single genus of Asiatic Œnochromidæ. *Auxima* and *Sarcinodes* are absolutely identical, and *Mergana* differs according to Walker in having two instead of four spurs to its hind tibiæ. The number of spurs, however, is probably variable even within the same species; nor can it be a sexual character, as out of two male specimens of *Mergana equilinearia* in the collection, one has two, the other four tibial spurs.

I submitted all the synonyms enumerated above to the consideration of Mr. Butler, who kindly endorsed their correctness.

MISCELLANEOUS.

The System of the Monactinellidæ. By Dr. R. von LENDENFELD.

THE rich collections of Australian sponges in the museums at Adelaide, Christchurch, and Dunedin, which were placed at my disposal by Dr. Haacke, Dr. J. von Haast, and Prof. Parker, as well as the material collected by myself among the Australian shore-sponges, include about 500 species, of which I have only been able to identify a few with forms already described. I have easily recognized among my specimens a number of the species accurately described by Selenka and Marshall, but have had little success in the identification of the species from the Australian region described by English and American authors.

As was very justly foreseen by O. Schmidt, it is not practicable to regard the system of the sponges established upon the Mediterranean fauna, and enlarged through the Atlantic forms, as universally applicable; uniting intermediate forms make their appearance where, from known facts, one would have suspected no relationship. However, the new forms furnish further proofs of the correctness of Zittel's system, and I have taken this as the foundation of my investigations.

The Calcispongiæ are few and insignificant. Hexactinellidæ and, singularly enough, Tetractinellidæ also are almost entirely deficient. Of the latter group I have obtained two specifically different individuals. As Myxospongiæ are also extremely rare (three species), the whole mass of the Sponges is distributed in the two groups of the Monactinellidæ and Ceraospongiæ.

I have carefully examined the Monactinellidæ especially, and will, in what follows, bring together the most important systematic results of this work.

Although I worked upon sponges at home for a long time under F. E. Schulze's guidance, and have also paid much attention to them in Australia, the investigation of so great a number of forms as has lately been at my disposal has compelled me to arrive at a clear idea of what is to be understood as a species among sponges. In the siliceous sponges it is here, as elsewhere, merely the form of the spicules, and never their arrangement, that behaves conservatively, and consequently can be applied to the establishment of the higher systematic groups. O. Schmidt's principle of division therefore applies also to the Australian sponge-fauna, divergent as it may be.

O. Schmidt has so far accepted a polyphyletic pedigree for the Chalinidæ as to derive the sponges with axial siliceous spicules in a network of horny fibres in part from the horny sponges and in part from the Renieridæ. I am in a position to describe a continuous series of forms which lead from the Ceraospongiæ to the true Renieridæ without any horny matter. There are all steps between the skeleton of the Chalcænidæ, consisting of spicules arranged in bundles and combined into thick cords, and the tissue of the typical Renieridæ, with its loose triangular meshes. Thus I possess a whole series of sponges the skeleton of which consists of parallel cords, representing the main fibres of the horny sponge. These cords consist of a dense mass of siliceous spicules, and are united with each other by *single* spicules of the same form, representing the uniting fibres. They are consequently separated from each other by the length of a spicule. In some of these sponges the main fibres are feeble and often bent, so that the looser Renierid tissue is formed by the weakening first of the uniting fibres and then of the main fibres of the Chalcænidæ. The Australian Renieridæ, however, show no relationship with the Myxospongiæ, from which they must have been derived, if not from the Chalinidæ.

Our sponges show that the non-ceratose Monactinellidæ represent the terminal members of a series which starts from the Ceraospongiæ. The spicules of the Monactinellidæ are either uni- or biradiates. (In this the biacuates ac^2 and *ac ac*, Vosmaer, are regarded as biradiates, and the obtuse-ended, tubercular, and pin-like forms *tr ac*, tr^0 *ac*, *tr ac sp*, Vosmaer, as uniradiates.) In agreement with F. E. Schulze, I regard the pluriradiate form as phylogenetically older.

I regard the spicules formed in the parenchyma of the sponge, the flesh-spicules, as in every respect essentially different from those which were deposited in the axes of the horny fibres, originally as biradiates, in the ancestors of the Chalinidæ. By reduction of the number of rays the obtuse-ended spicules have thus been developed from the biradiates, and from these again the pin-like and tubercular forms. In many cases a gradual disappearance of the horny substance takes place *pari passu* with the transformation of the spicules, while in other cases again the spongioline disappears without the spicules changing their form.

If we now consider the Monactinellidæ from this point (for the present without reference to the flesh-spicules), we obtain the following classification, in which they form as a whole an order "Monactinellidæ" in the class of Sponges:—

Suberitidæ.

Uniradiates without perceptible horny substance.

Chlathridæ.

Network of horny fibres with imbedded obtuse spicules.

Renieridæ.

Biradiates without perceptible horny substance.

Echispidæ.

Network of horny fibres with imbedded uni- or biradiates and projecting tubercular spicules.

Chalcœnidæ.

Network of horny fibres with dense masses of coarse imbedded biradiates.

Chalarchidæ.

Network of horny fibres with scanty, axial, extremely delicate biradiates.

Ceraospongiæ.

The Chalarchidæ and Chalcœnidæ, at least the Australian forms, are so different from each other, that for the sake of uniformity I have preferred to divide the Chalinidæ of authors into these two main sections. O. Schmidt's numerous families of Chalinidæ would in this scheme appear as subfamilies.

Among the Chalarchidæ we find sponges resembling *Euspongia*, *Cacospongia*, and *Spongelia*. Possibly therefore the pedigree of the Chalarchidæ may be polyphyletic, different members of the family being descended from the above-mentioned horny sponges.

I will here mention a peculiar intermediate form which combines characters of the Chalarchidæ with those of *Spongelia*. The skeleton of this sponge consists of a ladder-like network of horny fibres. The radial main fibres are entirely filled with sand, and bear no spicules. The tangential uniting fibres, which are not much weaker and do not anastomose with each other, are entirely filled with axial, evidently self-formed biradiates, and bear no foreign bodies.

The Echispidæ for the most part coincide with Gray's Echinonemata.

I have found an interesting form which so far unites this family with the Chlathridæ, that we find in this sponge projecting, obtuse, perfectly smooth spicules in great quantity, but no tubercular spicules.

Among the other three families which include O. Schmidt's groups of the same names, we should then have the Desmacidonidæ* to distribute.

I have proposed the foregoing classification without reference to the flesh-spicules, the multifarious anchors, hooks, &c. of the Desmacidonidæ, and without taking into account the siliceous stars in the cortex of many Monactinellidæ.

I regard it as preferable not to adduce the flesh-spicules in the formation of the principal groups, but rather to employ them as generic characters. Although I have long been inclined to this view, I have hitherto refrained from bringing it forward, as authorities like Vosmaer and O. Schmidt lay great stress upon the separation especially of the anchor- and hook-bearing sponges and their collocation to form a whole. In the same way, however, that O. Schmidt united sponges with and without siliceous stars in the family Gumminеæ, I think we may bring together Monactinellid families with and without anchors &c., provided they agree in the structure of the fibrous skeleton.

I believe that these flesh-spicules are of cœnogenetic origin. O. Schmidt has demonstrated that in part they contain much more organic material than those siliceous structures which occur in the corals. Their cœnogenetic character is especially proved by the extraordinary multiplicity and variability of their forms. In sponges which show themselves to be nearly allied by the character of their fibrous skeleton we often find anchors in one and nothing siliceous in the parenchyma of another; while, on the other hand, hooks occur in very different sponges. We usually meet with them in sponges the fibres of which contain Monactinellid spicules. But I possess a well-preserved spirit-specimen of a sponge from Port Phillip, which is a true *Hircinia*, and the fibres of which contain no siliceous spicules, while in its parenchyma, besides the filaments, great quantities of S-shaped double hooks are to be found.

The same applies to siliceous stars. These may sometimes occur and sometimes be deficient in nearly allied forms, while, on the other hand, they are found in very different sponges.

If we represent the system of the sponges in the form of a genealogical tree, taking the above conceptions as the foundation, we arrive at the following conclusions:—

1. From the Myxospongiæ originates a series of forms, the central members of which resemble the Spongidæ. From the sides of this series branches are given off, at the extremities of which stand the Aplysinæ and Hirciniæ. The Chalarchidæ and Chalcœnidæ are placed in the upper part of the series, from the end of which the Renieridæ, Suberitidæ, and Echispidæ radiate like an umbel. The

* O course I can here refer only to the most important groups.

Gummineæ have branched off between the Myxospongiæ and the Spongidæ.

2. In all the forms of this series, from *Halisarca* to *Suberites* or *Reniera*, we meet with the tendency to form flesh-spicules.

3. The flesh-spicules are quite independent of the rest of the skeleton, and occur in two types, Monactinellan (anchors &c.) and Polyactinellan (stars &c.).

4. When another skeleton was already formed by production of fibres, when the flesh-spicules originate they remain small and unimportant, and in this case it is of no consequence whether the fibrous skeleton consists of horny substance (*Hircinia*), connective cords (Gummineæ), or siliceous cords (Desmacidonidæ).

5. When there was no fibrous skeleton when the flesh-spicules were formed they attained considerable dimensions, and on their own part formed connected frameworks. Both the Monactinellan and the Polyactinellan forms occur in these sponges. The anchor-spicules of the Tetractinellidæ perhaps belong in part to the former, and the structures in Tetractinellidæ and Hexactinellidæ originating by reduction of the many rays to 4 or 6 to the latter group. The Plakinidæ unite all these with *Halisarca*.

From the series of fibrous sponges which culminates in the non-horny Monactinellidæ branches are given off at many points in the same direction, all parallel to that powerful but homologous branch which contains the Hexactinellidæ and Tetractinellidæ.—*Zoologischer Anzeiger*, No. 164, April 7, 1884, vii. p. 201.

On Orbulina universa. By M. C. Schlumberger.

Several naturalists have already paid attention to the genetic relations which appear to exist between the *Orbulinæ* and the *Globigerinæ*, which are so abundantly distributed in our seas. Pourtalès* was the first to indicate the presence of a *Globigerina* in the interior of *Orbulinæ* dredged in the Gulf-stream. Dr. A. Krohn † made the same observation upon living *Orbulinæ* taken at Madeira. These two observers ‡ concluded that the *Orbulina* gives origin to a *Globigerina*, which, increasing in size, finally bursts the sphere which encloses it and escapes to lead an independent existence. Carpenter §, in his classical work on the Foraminifera, opposes this opinion by a series of irrefutable arguments and retains the two genera *Orbulina* and *Globigerina* founded by D'Orbigny.

Recent researches upon the embryogeny of the Foraminifera have

* Silliman's Journal, July 1858; reprinted in this Journal, ser. 3, vol. ii. p. 235.

† Referred to in a paper by Prof. Max Schultze, in the Arch. f. Naturg. 1860, p. 287; translated in this Journal, ser. 3, vol. vii. The point is discussed at pp. 311–313.

‡ Krohn simply observed the fact and communicated it to Max Schultze.

§ Introduction to the Study of Foraminifera, 1862.

led me to interpret the facts observed in a manner quite different from that which had been regarded as admissible. In examining the sands from a deep dredging (4255 metres) executed by the 'Talisman' at the Canaries, I found a great number of *Orbulinæ* of all sizes, and so clean that when soaked in chloroform and immersed in Canada balsam they became perfectly transparent. It is then observed that among the smallest of only 320 μ in diameter, and those of medium size, some are empty, while others have their cavity occupied entirely or in part by a succession of globular chambers arranged in a trochiform spire, like those of certain *Globigerinæ*. The large *Orbulinæ*, attaining nearly 1 millim. in diameter, are almost always empty.

These interior chambers are more easily distinguished after the removal of a portion of the *Orbulina*, or when entirely separated from their envelope. We then find that their exceedingly delicate plasmostracum is pierced by distant perforations; the chambers of the first two turns of the spire are smooth; the following chambers bear fine scattered spines, which, upon the last ones, are prolonged to the inner wall of the *Orbulina*, to which they attach themselves *. These chambers communicate with each other and with the interior of the *Orbulina* by a small semilunar aperture, situated below and opposite to the turn of the spire. In the largest *Orbulinæ* the spire does not include at the outside more than sixteen chambers.

Now all *Globigerinæ*, as Carpenter points out, even when young, have a comparatively thick plasmostracum, very closely placed perforations, one or several apertures widely invading the chambers, and a rugose exterior, in consequence of the great number of spines which cover its surface. Hence between the interior chambers of the *Orbulinæ* and the *Globigerinæ* there is only a resemblance of form.

On the other hand, we find many small *Orbulinæ* in which the last or last two interior chambers form projections upon the sphere; but then these protuberances are surrounded by a plasmostracum as thick as the rest of the envelope. The interior chambers therefore do not quit the *Orbulina*; further, if they did so we ought never to meet with large empty *Orbulinæ*.

From these facts we can draw only one logical conclusion, namely, that we have before us a case of dimorphism analogous to those which M. Munier-Chalmas and myself have already indicated in the Nummulites †, the Miliolidæ ‡, and many other genera of perforate and imperforate Foraminifera §.

The single chamber of the *Orbulina* is the homologue of the initial chamber of the other Foraminifera; when it remains empty

* This fact was observed by Pourtalès.

† Bull. Soc. Géol. Fr. sér. 3, viii. p. 300; 'Annals,' ser. 5, vol. xi. p. 336.

‡ Comptes Rendus, 1883, pp. 862 and 1598; 'Annals,' ser. 5, vol. xii. p. 67.

§ Feuille des jeunes Naturalistes, 14e année; Congrès de Rouen, p. 520 (1883).

it is of the form A; with the series of interior chambers it is of the form B. But it is necessary to remark that, as among the *Orbulinæ* we meet, on the one hand, with large empty individuals, and, on the other, with small individuals, some empty, some with interior chambers, we cannot assume in this case, as has been indicated for Miliolidæ, an absorption of the large embryonal chamber.

The case of the *Orbulinæ* is in favour of our first hypothesis, and seems to demonstrate that the dimorphism of the Foraminifera is an initial character, the result of two original forms.—*Comptes Rendus*, April 21, 1884, p. 1002.

On the Ascidian Genus Rhopalea. By M. L. Roule.

Philippi first described (Müller's Archiv, 1843), under the name of *Rhopalea neapolitana*, an Ascidian that he had collected in the Bay of Naples, and of which he has given a short anatomical description, but sufficiently accurate as to most of the details of organization that he has noticed. In his memoir he approximated this new genus *Rhopalea* to the *Clavellinæ*. Since Philippi's time, so far as I know, no other naturalist has studied this curious form of Ascidian; Traustedt does not notice it in his work upon the simple Ascidia of the Bay of Naples (Mittheil. aus der zool. Stat. zu Neapel, 1883), and Herdman (Tunicata collected by the 'Challenger'), referring to the description given by Philippi, places it alongside of *Ecteinascidia*, in the family Clavelinidæ.

The *Rhopaleæ* are very abundant on the shores of Marseilles on the bottom surrounding the *Zosteræ*, in the muddy sands collected by the currents at depths of from 25 to 60 metres; hence I have been enabled to observe numerous individuals and to make a regular investigation of them. The body, of an average length of 8 to 10 millim., of a nearly pure white colour, is divided into two parts —one anterior, of triangular form, free, containing the branchia, and bearing the two siphons (buccal siphon with eight or nine, and cloacal siphon with six papillæ); the other posterior, of irregular form, adherent to the ground, and incrusted with débris of various kinds, containing the mass of the viscera. These two parts are joined together by a slender region of considerable length, through which the rectum, filled with substances destined to be rejected, may be distinguished; the general aspect much resembles that of a somewhat stout and very large *Clavelina*.

The thick tunic is of a soft consistency around the anterior part of the body, firm and resistant around the posterior part. In this latter region the fundamental substance of the tunic encloses numerous vacuolar cells, while it contains none in the anterior region. The dermis (mantle), which is thin, bears small muscular bundles, most of which run in the direction of the length of the body; around the siphons there also exist a certain number of annular muscular bundles. Philippi erroneously regarded as a peritoneum the portion of the dermis which surrounds the posterior visceral mass. The fundamental web of the branchia, the apertures of which are oval and regularly formed, is folded longitudinally; the folds are very small, invisible to the naked eye, and in this respect resemble those of the branchia of the *Phallusiæ*. The transverse branchial sinuses are united to the longitudinal sinuses by an anastomotic branch, which does not project into the interior of the branchial cavity beyond the longitudinal sinuses, to produce papillæ like those possessed by most of the simple Ascidia. The dorsal raphe is constituted by a series of papillæ; it terminates in front, not far from the vibratile organ, and in this region the pericoronal groove sends towards it a small prolongation analogous to that which that groove bears in the *Cionæ*. The peribranchial cavity does not communicate with the empty spaces left between the viscera in the posterior region of the body, lacunæ which may be regarded as forming by their union a reduced general cavity; it is stopped immediately behind the branchia by a peritoneal lamina, like that of *Ciona*.

The other organs are constituted nearly in the same way as in the *Cionæ*. The only important differences relate to the arrangement of the sexual organs, which are collected into a single mass surrounding the intestinal cavity, and to the greater length of the œsophagus and rectum. With the exception of these not very important distinctions, the digestive tube, the nervous system, the hypoganglionic gland and its excretory duct, the heart, and the principal sinuses &c. present the same fundamental structure as in the *Cionæ*.

The relations of the *Rhopaleæ* with the other forms of Ascidia are multiple. By their general facies, it is true, they approach the Clavelinidæ; but we cannot place them in that family, for they do not reproduce by gemmation and possess a more complex organization. We must class them among the Phallusiadæ, and regard them as establishing a close connexion between the simple and aggregated Ascidia; by their viscera situated behind the branchia and a certain number of less important characters, they are more nearly allied to the *Cionæ* than to the true *Phallusiæ*; but they nevertheless approximate to the latter by the presence of longitudinal folds in the branchial wall. The affinities of the *Rhopaleæ* are therefore numerous, and they form as it were a bond of union between several different groups; in the general arrangement of their organs they show a certain resemblance to the *Clavelinæ*, while at the same time they are simple Ascidians very nearly allied to the *Cionæ* and also presenting some relations to the *Phallusiæ*.—*Comptes Rendus*, May 19, 1884, p. 1294.

On the Process of Digestion in Salpa. By Dr. Ch. S. Dolley.

The author remarked that, preliminary to giving the full results of a somewhat extended study of the histology of *Salpa*, he desired to make a few remarks in reference to certain statements recently made by Dr. A. Korotneff of Moscow *, which he considered erroneous in so far as they indicate the presence of a huge amœboid cell or plasmodium, in the œsophagus and stomach of *Salpa*, functioning as a digestive organ. Dr. Korotneff describes this cell as arising from the repeated division of a single cell which early in the life-history of the animal is separated from the intestinal wall. This giant cell or plasmodium, acting like a huge rhizopod, carries on a form of parenchymatous digestion of the food taken by the animal, passing the resulting chyle into the walls of the intestine by means of its pseudopodia. Now by reference to an article by Metschnikoff "On Intracellular Digestion in Invertebrates" (in the 'Quarterly Journal of Microscopical Science' for January 1884), it will be seen that such a form as Korotneff describes has never been met with, and his description stands alone and anomalous, both as regards the situation and size of the digestive plasmodium and as to the method of its formation, for in all cases in which such structures have been found in Invertebrates they have always arisen by the fusion of separate cells, not from the repeated division of one cell. In a large number of series of sections made by the new "ribbon" method, the speaker was not only unable to find "the lumen obliterated" by the peculiar structure of the wall of the intestine described by Korotneff, but in a model of the visceral nucleus made after Born's "Plattenmodellirmethode" the lumen of the entire intestinal canal is shown to be completely free throughout. He did, however, get sections which gave pictures almost identical with those portrayed by Korotneff, *i. e.* the lumen filled with what he describes as a large nucleated granular cell, containing various food-particles, and he could trace this so-called "cell," not only back into "the portion of the intestine lying next to the stomach," but through the rectum into the cloacal chamber, and through the œsophagus into the branchial sac. He accounts for it as follows:— The endostyle of *Salpa* has been very carefully studied by Hermann Fol, who demonstrated, by means of carmine suspended in water, that it threw out a constant stream of mucus when excited by the presence of nutritive material in the same water, with a reflex action, like a salivary gland. The mucus is, by an arrangement of cilia, spread out like a curtain over the inner surface of the branchial sac, when it acts as a means for catching the food-particles from the ingurgitated water. By the action of ciliary bands bordering the groove of the endostyle, the mucus is swept towards the œsophagus, and as it approaches this, it is, by means of the stiff cilia on the sides of the gill, twisted into a thread, and carried by a continuation of the aforesaid bordering bands through the œsophagus into the stomach. Now in studying a series of sections of a *Salpa* which had had abundant food, we found as we approached the œsophagus a mass of material answering to the description of Korotneff's "rhizopod." It takes staining readily and may be traced backward into

* "Ueber die Knospung der *Anchinia*," in Zeitschr. f. wiss. Zoologie. Bd. 40, Hft. i. (1884).

and through the œsophagus, stomach, and intestine. As the sections approach the rectum, however, the mass gradually ceases to take staining, and is much more distinctly marked out from the intestinal wall, having had all the organic matter digested out, and consisting only of the inorganic remains, which do not stain. The alimentary matter of *Salpæ* is composed of animal and vegetal elements in nearly equal proportions, and the microscope reveals the calcareous shells of Foraminifera, the beautifully sculptured frustules of Diatomaceæ, keen siliceous needles, and the sharp armatures of minute Crustacea.

In the fore part of the intestinal canal, the food-mass, staining almost as readily as the wall of the gut itself, seems to merge into the ill-defined epithelium of the latter, and it is scarcely possible to say where the food-bearing mucous thread ceases and the intestinal epithelium begins, especially as this latter has a rugous arrangement. That we have here to do with a form of digestion entirely anomalous and unprecedented, he could not believe, and begged leave to differ from Dr. Korotneff on this point. Fol and others have recognized the endostyle as a sort of salivary gland, and have traced its food-laden mucous thread into the stomach of the living animal, while the speaker had been able to trace the same thing in well-preserved specimens. He had also several series of sections from animals which must have been without food for some time previous to death, in which the lumen of the intestine is not only free of food, but of any obliterating mass of cells or plasmodium. The only protoplasmic bodies not food are certain *Gregarina*-like organisms adhering to the walls of various parts of the intestine, and which he took to be parasites. These give on section the appearance of the large "scattered cells, entirely free from their surroundings," which Korotneff figures and regards as "analogous to the great stomach-cell of *Anchinia*." The first opportunity would be taken to examine these structures in living *Salpæ*; but he was now forced to conclude that Dr. Korotneff has endowed the food-bearing mucous thread with a power it does not possess, that *Salpa* does not exhibit any unusual form of intracellular digestion, and that there is no immediate cause on its account for questioning the high genetic place occupied by the Tunicates.—*Proc. Acad. Nat. Sci. Philad.*, April 15, 1884, pp. 113–115.

On a Species of Tachina *occurring on the Tracheal System of* Carabus. By M. N. Cholodkowsky.

In the summer of the year 1882, when I was examining various species of the genus *Carabus* for purposes of comparative anatomy, I found on the abdominal stigmata of some specimens of *Carabus cancellatus* some peculiar small whitish bodies which projected freely into the body-cavity of the beetle. These bodies were of an oval form and about 1 millim. long. On closer examination, after cutting out the stigma with a small piece of skin and with the tracheal stem starting from the stigma, the following proved to be the case. The oval whitish body had one end turned towards a thick tracheal stem close to the stigma, and this end of it was pushed into a brownish chitinous cup which surrounded it, but the narrow base of the cup was attached to the trachea. After removing the whitish body from the cup it could be seen that at the bottom of the latter there was a small aperture leading into the trachea. From the margins of the cup extended irregular translucent chitinous deposits which surrounded the whitish oval body. On microscopic observation of the whitish oval body annulation was observable upon it; tubular organs (alimentary canals) shimmered through from the interior; at the end turned towards the body-cavity (of the *Carabus*) sharp hooklets were observed, and at the opposite extremity two respiratory apertures. From these characters a young *Tachina*-larva was easily recognized in these little bodies. Soon after I obtained some specimens of *Carabus cancellatus*, each of which was infested with several *Tachina*-larvæ already full-grown. The larvæ were so large that they filled nearly the whole ventral cavity of the beetle. The beetles infested by *Tachinæ* were distinguished by their sluggishness from those not so attacked, and soon died in captivity. The chitinous cups which embraced the hinder extremities of the large larvæ were large and had an irregular margin; the translucent chitinous deposits which surrounded the body of the larva were greatly developed and had the form of irregular and in part confluent lobes. In short, chitinous pathological structures surrounded the body of the larva just as inflamed connective formations enclose foreign bodies which have got into the body of a vertebrate animal. This fact is certainly in favour of the conception of chitine as the physiological equivalent of the connective tissue in the bodies of insects. There is no doubt that the deposition of chitine took place from the soft hypodermal layer of the wall of the trachea. Besides *Carabus cancellatus* I obtained a specimen of *Carabus glabratus*, which was also infested by numerous larvæ of *Tachina*.

I did not succeed in rearing a single fly from any of these larvæ, partly because I had other purposes in view in the investigation of the species of *Carabus*, but partly because the infested beetles did not live long in confinement. I hoped to have obtained some infested *Carabi* in the summer of 1883, but none of the beetles of this kind collected by me that summer contained *Tachina*-larvæ. On the other hand. I found a specimen of *Harpalus ruficornis* which was literally stuffed with these larvæ.

The occurrence of *Tachina*-larvæ in the bodies of adult insects is by no means a new fact. As long ago as the year 1828 Boheman found the larvæ of *Uromyia curvicauda* in *Harpalus ruficornis* and *H. aulicus* *. Léon Dufour has described *Hyalomyia dispar*, which is parasitic in *Brachyderes lusitanicus* † ; and he also found the larvæ of *Phasia* in *Pentatoma grisea* and *Cassida viridis* ‡, and the

* Stockholm Akademiens Handlingar, 1828, p. 164.
† Ann. Soc. Ent. Fr. 1852, p. 443.
‡ Ibid. 1848, p. 427.

larva of *Ocyptera bicolor* in *Pentatoma grisea* *. As regards the species of *Carabus*, Boye, in the year 1838, reared *Tachina* from *Carabus violaceus*, *cancellatus*, and *clathratus* †. The description of this fly under the name of *Tachina pacta* is to be found in Zetterstedt ‡.

Since that time, so far as I know, no *Tachina*-larvæ have been found in species of *Carabus*. The species *Tachina pacta* is very little known and very doubtful. Our Russian dipterologist, J. A. Portschinsky, to whom I am indebted for many references to literature, is of opinion that *Tachina pacta* is identical with *Tachina* (*Masicera*) *cinerea*. Zetterstedt himself says of *Tachina pacta* that it is "valde similis et affinis *Tachinæ cinereæ*." Schiner is of the same opinion.

As regards the mode of penetration of the larva into the body of the *Carabus*, we must, in all probability, consider that the fly deposits its egg in the stigma, and the larva, escaping from the egg, bores through the wall of the trachea and gradually extends its body into the body-cavity of the beetle. During this time there are formed around the larva, on the part of the hypodermal layer of the trachea, chitinous deposits, which are strongest in the vicinity of the abdominal wall at the hinder extremity of the larva, and here form a brown cup, the margin of which, however, passes without any sharp boundary into the translucent chitinous lobes which surround the rest of the body of the larva.

A little while ago, Jules Künckel d'Herculais described a parasitic fly (*Gymnosoma rotundatum*), the larva of which lives in the body of *Pentatoma* §. In this case also the larva has its hinder extremity turned towards the stigma, and this end is embraced by a chitinous cup, called by Künckel "le siphon." Künckel, however, thinks that "le siphon" is a secretion of the larva itself, and by no means a product of the hypoderm of the infested insect. Künckel also describes the mode of penetration into the body in a different fashion, namely, that the fly sticks its eggs to the ventral segments of the *Pentatoma*, and the escaping larva penetrates between the ventral segments into the abdominal cavity and only by degrees becomes connected with the stigma. However this may be with regard to the *Pentatoma* and *Gymnosoma rotundatum*, in *Carabus* the case is most probably as I have suggested. The penetration of the larva through the stigma is in this instance evidenced by the fact that even the very smallest larvæ are attached to the stigma, and that they are only met with on the stigma.—*Zoologischer Anzeiger*, no. 169, June 9, 1884, p. 316.

* Ann. Sci. Nat. tome x. p. 248.

† 'Kröyer's Naturhistorisk Tidsskrift,' 1838. See also Erichson's 'Bericht über die wiss. Leistungen im Gebiete der Entomologie im Jahre 1838,' Berlin, 1840, p. 93.

‡ 'Diptera Scandinaviæ,' tome iii. pp. 1038–1039.

§ Ann. Soc. Ent. Fr. sér. 5, tome ix. (1879).

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IX.—*Notes on Species of* Ascodictyon *and* Rhopalonaria *from the Wenlock Shales.* By GEORGE ROBERT VINE.

IN the 'Annals and Magazine of Natural History' for June 1877, Prof. H. Alleyne Nicholson and Robert Etheridge, jun., published their joint paper on "*Ascodictyon*, a new Provisional and Anomalous Genus of Palæozoic Fossils." In that paper (pp. 463–468) the authors describe forms from the Devonian (Middle, of Ontario) and Carboniferous strata (of Scotland). In a paper read before the Geological Society and ultimately published in their journal ("Notes on the Polyzoa of Wenlock Shales," Feb. 1882), I placed upon record (p. 54) the name *Ascodictyon filiforme*, Vine, as a provisional one. Since the publication of that paper I have been closely engaged on the study of Silurian and Carboniferous *Ascodictya*, and I find that the forms that I originally placed under the above name may conveniently remain. The organism, however, is such a peculiar one, and my opportunities of studying its varied aspects so singularly fortunate from the possession of a large series of specimens, that I make no apology for adding further details of the species to the brief notice already referred to.

The genus *Ascodictyon* is Palæozoic, though not peculiarly so. In examining a series of Cretaceous Polyzoa in the possession of Miss E. C. Jelly, one specimen appeared to me to belong to the genus.

In describing an American Silurian form—in some respects similar to forms found in the Wenlock Shales—Mr. E. O. Ulrich (Journ. of Cincinnati Soc. Nat. Hist. April 1879, pp. 18, 19) has established a genus under the name of *Rhopalonaria*. The species of the genus, *R. venosa*, Ulr., the author places with the Crisiidæ, remarking, "that the form has only been observed incrusting *Streptelasma corniculum*. On account of the great delicacy of the fossil, the fronds themselves are rarely found; but instead we find a series of impressions on the exterior coat of the *Streptelasma*, which very well represents the fronds and cells of the same." A specimen of the species described by Mr. Ulrich is before me. It is from the same Cincinnati rocks; as I shall have to refer to the genus again, I have thought that it might be more satisfactory to make reference to an actual specimen than to the mere description of the same.

ASCODICTYON, Nicholson & Etheridge, Jun.

Ascodictyon, Nich. & Eth. jun., Ann. & Mag. Nat. Hist., June 1877, pl. xix.; "Notes on Polyzoa of the Wenlock Shales," Vine, Quart. Journ. Geol. Soc. Feb. 1882, pp. 52, 53.

1. *Ascodictyon filiforme*, Vine.

Ascodictyon filiforme, Vine, "Notes on Polyzoa of the Wenlock Shales," *op. cit.* pp. 54, 55 (merely referred to in the above).

Organism filamentous, forming linear, contorted or clustered threads, adherent to shells, stems of crinoids, fragments of trilobites, but rarely to corals. *Filamentous* threads hollow, but surrounded by delicate calcareous walls; the hollows filled with a dark brown granular mass. *Lagena*-like divergences developed on the sides of the thread, sometimes as single vesicles, otherwise as groups of vesicles. Peculiarly clustered stellate fibres are also formed at unequal distances.

Locality. Buildwas beds, generally distributed throughout the whole of the washings, but more abundant in nos. 36 and 38.

This curious organism begins its existence as a mere speck upon stone or shale or stem, which forms the nucleus of a colony. From this delicate filaments are developed (fig. I. 1 *a*, a^1), sometimes in two or three, at other times in four different directions; these vary in thickness, but the average size, both in breadth and depth, may be taken as measuring between $\frac{1}{130}$ and $\frac{1}{200}$ inch. The threads are sometimes, but rarely, white, more generally of a dark brown tint. Viewed as opaque objects on shell-fragments they appear like fine hairs laid in lines across the surface, or contorted, crossing each other at different angles, or running in parallel lines; but it would be useless to direct attention to any special feature in their modes of growth, for they vary considerably; but one

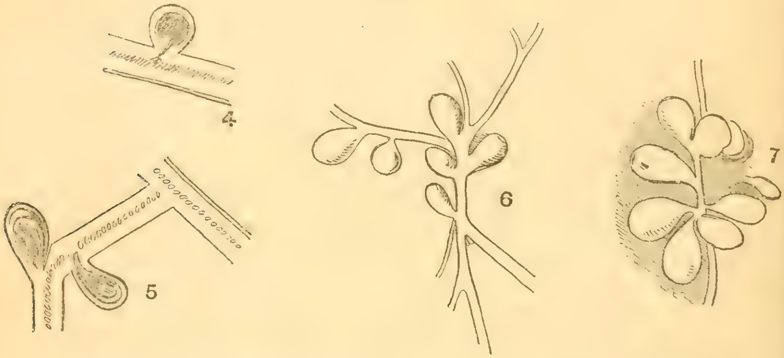
Fig. I.

1. *Ascodictyon filiforme*, Vine, $\frac{1}{180}$ inch thick. Two filiform threads running almost parallel. The point of origination is a^1; the portion marked a is nearly similar, but wanting the nucleus; a^2 single vesicle.
2. *A. radiciforme*, Vine, $\frac{1}{130}$ inch thick. One of the filiform contracted threads, placed here for comparison.
3. Thread of *A. filiforme*, drawn from a transparent specimen, showing dark brown pulp.

feature which appears to me to have something to do with the development of the colony must not be lost sight of. Occasionally some of the filaments bifurcate, and before bifurcation takes place the organism contracts at intervals, and out of this contracted portion a new thread originates. It must not be supposed, however, that this simple explanation is, on the whole, a plainly satisfactory one. The two different sorts of threads, though apparently allied, give rise to two distinctly separable colonial growths in the after stages of their existence. Yet in the earliest, or initial stages, it is not easy to distinguish the difference between them. It will be better, however, to keep the two forms distinct.

In a few cases I have been able to reduce the thickness of the shell to which a typical *A. filiforme* is attached, and have mounted the specimen in balsam on glass. It is then seen that the filament is hollow, and the central parts filled with a dark brown granular matter. This granular matter, which I shall call the pulp, is sometimes continuous, at other times slightly separated from the adjoining mass, when the grains appear like a row of beads dotting the centre of the threads (figs. I. & II. 3 to 5). Surrounding the pulp are delicate and transparent walls, which are distinct and clearly defined. In a few cases the filament bifurcates and the pulp in the undivided portion separates at the node and passes into the divisions thus formed. Real development takes place at irregular intervals. On the sides of the thread there is a slight protuberance of the wall, which increases in size until a roundish knob or a lagena-like vesicle is formed. Into these vesicles, which may be either single or in groups, the pulpy mass passes; but to what extent the colony increases beyond the *A.-siluriense* stage, I am unable to say; although I believe we may safely regard this species, at least, as the ultimate outcome of the colonial development of *A. filiforme*, Vine.

Fig. II.



4, 5. *Ascodictyon filiforme* (transparent and semitransparent), showing vesicles and pulp.
6. Ditto, showing clusters of vesicles, passing into
7. *A. siluriense*, Vine.

At this stage of inquiry it may be well to ask, whether the name *A. siluriense*, Vine (Wenlock Polyzoa, *op. cit.* p. 52), should be suppressed. If the Silurian name is suppressed the Devonian name (*A. stellatum*, Nich. & Eth.) must be suppressed also, unless the one name may be allowed to embrace both the type and the varieties. In opposition to this view, I think the wiser course would be to allow the forms to retain their present names as given below, for the simple reason that it would be perhaps impossible, or almost impossible, to make another collection similar to my own unless the shales were searched with the same minute care that I have bestowed upon those furnished to me by Mr. George Maw. Then, again, *A. siluriense* and *A. radiciforme* were the firstfruits of my labours; and *A. filiforme* was the result of closer examination. As with me so with others, because the matured forms will, I fancy so at least, be considered by the student of micropalæontology as by far the most important as initial stages in an inquiry like the present one. Another consideration is with me of much greater weight than any previously given. It may be, after all the care that I have exercised in thus tracing the origin and development of a colonial growth, that some few facts or fossil illustrations may have been overlooked, and it may be necessary at some future time to limit the type now characterized as *A. filiforme.* If this should happen, the suppressed names would have to be restored.

In his observations on *A. stellatum* Prof. Nicholson remarks (*op. cit.* p. 465), that in its youngest stage the organism "presents itself simply in the form of scattered oviform or pyriform calcareous vesicles attached to the exterior of foreign bodies. When mature it consists of similar vesicles combined into clusters." I do not doubt the accuracy of Prof. Nicholson's observations, though I cannot, on the whole, endorse them from my own labours: all the vesicles are united to the filiform thread, though in a few isolated instances "apparently" they are not so. I have examined a large series of *A. filiforme* for the purpose of putting the observations of Prof. Nicholson to the test, and I am consequently unable to confirm his views. In his description of fig. 6, pl. xix. (*op. cit.*), the author says, "Four young vesicles (?) of the same (*A. stellatum*) &c.;" the vesicles are not foraminated, as in the other figures (2 to 5, pl. xix.), and in this special feature the Ontario vesicles are allied to, though not identical with, those shown in fig. II. of the present paper as gradational stages in the development of *A. filiforme*, Vine.

2. *Ascodictyon stellatum*, Nich. & Eth., jun., var. *siluriense*, Vine.

=*Ascodictyon stellatum*, Vine, Quart. Journ. Geol. Soc. Nov. 1881, p. 618.
=*Ascodictyon stellatum*, var. *siluriense*, Vine, Q. J. G. Soc. Feb. 1882, p. 52.

The details of this species have been given in the works referred to above.

3. *Ascodictyon radiciforme*, Vine.

=*Ascodictyon radians?*, Vine, Quart. Journ. Geol. Soc. Nov. 1881, p. 619.

=*Ascodictyon radiciforme*, Vine, Q. J. Geol. Soc. Feb. 1882, p. 53.

When I wrote the details already given in the papers referred to above I did not possess the fine suite of specimens which has enabled me to extend my remarks on the origin, growth, and apparently final (?) development of this peculiar group of organisms, found as yet only adherent to other organisms in the Wenlock shales.

In speaking of *A. filiforme*, I incidentally referred to a single form apparently related to the species, but which I said it would be best to keep separate. I have now to consider the relationship of that form, but which, not being the earliest in the development of the species, I will defer till later on.

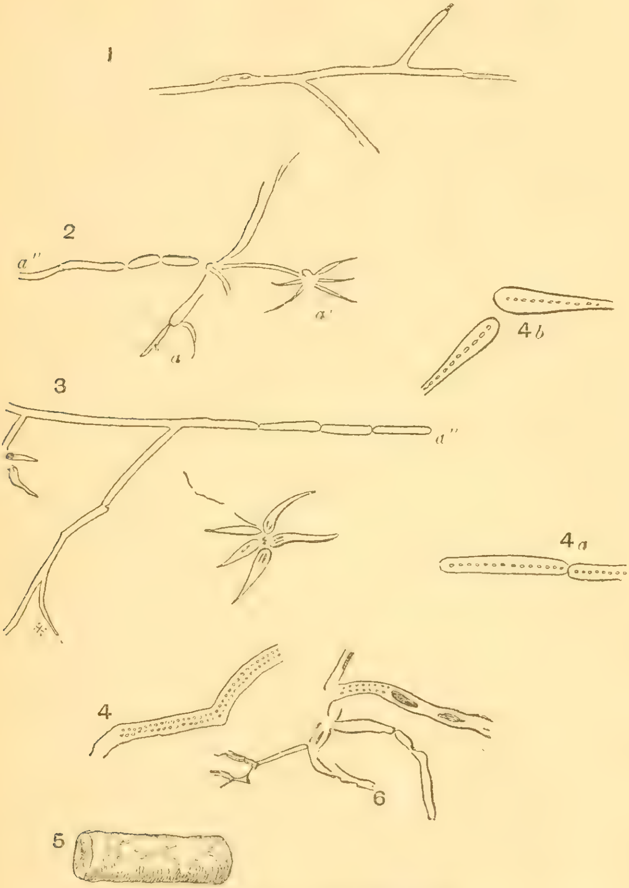
In fig. III. 5 I have sketched the fragment of a crinoid stem, magnified about 2 diameters, on which one of the finest of my colonies of the earliest stages of this species (*A. radiciforme*) is attached. I do not, however, found the whole of the evidence which I am about to bring forward on a single specimen. I have corrected both the positive and the negative evidence by appeals to between sixty and seventy other specimens; but as this one affords me evidence of continuous growth, I have built up my description mainly on it. And here I must be allowed to say that, contrary to my general plan in drawing, the whole of my sketches are drawn by the eye, and not by the aid of the *camera lucida*; but every figure is a faithful delineation of the original.

In fig. III. 1, 2, and 3 I have drawn a fibre which is continuous on the fragment of crinoid stem already referred to. At 2, *a* and *a'*, we have two nuclei, either of which may be referred to as the originating nucleus of the colony; but it will be best to speak of them separately. In fig. III. 2, *a*, a kind of false stellate cluster is formed; but this I regard as only an offshoot; the true nucleus is at *a'*, and at this the central part only. It appears to me that the central nucleus originates by the combination of minute spores, which up to the present have escaped my observation; but immediately after the combination, delicate prolongations of the central mass or radii are sent off which do not in every case produce fibrous threads. At *a'* one of these minute combinations is formed, but only one of the rays is apparently developmental *.

* It will be understood by the palæontologist that in restricting myself thus I only take the evidence presented to me. I have not the least doubt but that what I say of one might be said of all the rays; but I have only the one evidence to rely upon—the positive.

This extends for a short distance, when another, or pseudo-combination, takes place, the result of which is shown, so far as I am able to trace it; but in that portion which recedes towards a'' the fibre is slightly contracted at certain distances.

Fig. III.



1 to 6. Varied forms of *Ascodictyon radiciforme*, Vine (already described in text).

In fig. III. 1 the fibre is white, undoubtedly hollow, with here and there a broken surface, showing the dark brown pulp (or matrix) below. In fig. III. 3, which is a continuation of fig. III. 2, at a'' we find the continuation of the contracted fibre and other features which it may be well for the reader to refer to, the stellate cluster being a continuation of the fibre at 3*. In following the above remarks it will be easily understood that I attach very great importance to the method of formation and the character of the tongue-like vesicles which form the radii of this anomalous species, *A. radiciforme*. Sometimes after single vesicles are formed, at other times after a combination of vesicles, the organic matter of the thread or fibre undergoes other changes, to which reference has not been made. A group of vesicles combined as in fig. III. 3*, some of the cells, and occasionally the whole of them, will contract towards the centre or separate from the nucleus, forming club-like cells. In nearly all the instances where I have seen this mode of contraction the cells have a very delicate covering of calcareous matter, and are foraminated either in a single line along the centre or indifferently over the whole surface; the latter, however, is a very rare occurrence. I have given figures of the club-like cells (fig. III. 4 *a*, 4 *b*), showing the direction and positions of the foraminated surfaces; but in fig. III. 4 I have shown the basal attachment of one of the fibres, which shows that the under surface was more densely foraminated than the upper. The irregular fibre shown in fig. III. 6, though not strictly speaking a portion of a stellate cluster, is likewise foraminated.

In the 'Journal of the Cincinnati Society of Natural History,' 1879, vol. ii. pl. vii. figs. 24 and 24 *a*, Mr. E. O. Ulrich describes and figures a very peculiar fossil adherent to the exterior coat of *Streptelasma corniculum*. For the species a new genus is founded—*Rhopalonaria*, from *rhopalon*, a club—which Mr. Ulrich places in the family Crisiidæ; and he says that "the genus is related to *Hippothoa*, but in the form and arrangement of the cells they differ widely." There is not, however, any relationship to *Hippothoa* in the species described; but as the cells are somewhat club-shaped, it may be well to accept the genus if more fully defined.

In the species, *R. venosa*, Ulr., the "cells are uniserial, long, acutely elliptical, and joined together at their contracted ends. . . . Cell-mouths not clearly determined, *but appear to be situated near the middle of the cell*" †. In my own specimen of this species I cannot detect any cell-mouths, but the other characters are well defined by the author.

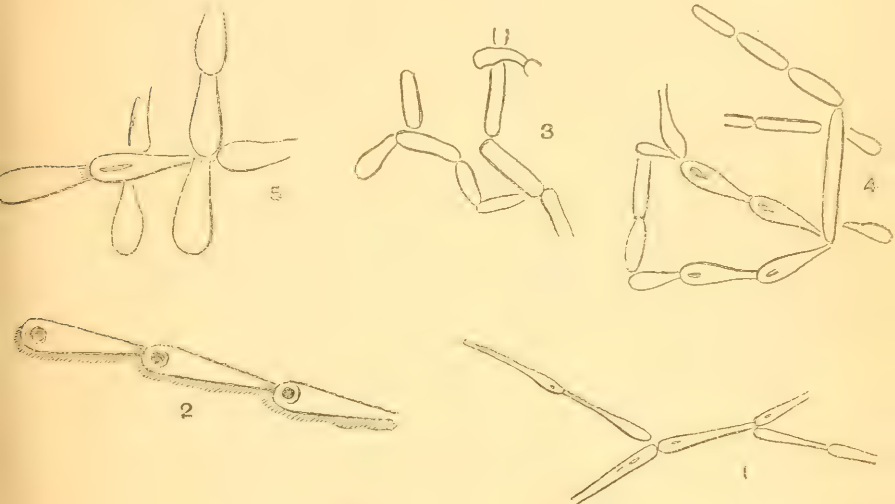
In the Ludlow rocks and also in the Wenlock shales there are several fossils that might have been conveniently placed in this genus if my specimens did not throw some little light

† Italics mine.

upon their origin and development. In fig. IV. I have given sketches of four distinct types of very common forms found in the shales. In fig. IV. 1 we have the rarest of these, showing elongated cells very similar to some of the cells of *Stomatopora elongata*, Vine (fig. IV. 2), only that the cells are in an opposite direction to what (apparently?) is the case in *S. elongata*. I cannot, however, detect any orifices in these cells such as we have in *S. elongata*.

Another form, very common indeed, is shown in fig. IV. 3. Only that the cells are not club-shaped, I suggested for this type *R. botellus*, as descriptive of its peculiar sausage-like character. But even of this type better evidence is afforded by

Fig. IV.



1, 3, 4, 5. *Rhopalonaria*, Ulrich; species described in text.
2. *Stomatopora elongata*, Vine.

fig. IV. 4, in which both the *botelloid* and the *rhopaloid* characters are shown in one colony. Some of the cells in the last figure have, one would suppose at first sight, cell-mouths. This is not so: those cells that are shown thus are a little more calcareous than the others; the walls are broken at this part, and the dark brown matter is shown below. I have some few specimens of the last two types, and the whole of the walls or outer covering is destroyed, and the *botella*-like matrix is still adherent to the fragments to which the original organism was fixed. In fig. IV. 5 we have a fourth and last type, which is similar in some respects to *R. venosa*, Ulrich *.

In addition to my own observations I have the evidence of a most careful observer as to the existence of *Rhopalonaria* in the Ludlow rocks. In 1881, J. D. Longe, Esq., of Cheltenham, sent me a series of sketches (fig. V.), with the

Fig. V.

Rhopalonaria, Ulrich, from the Ludlow rocks. Figures supplied by J. D. Longe, F.G.S., Cheltenham.

following remarks:—"I also enclose a sketch of a very abundant, encrusting, creeping 'stoloniferous' form, which I have on shells (*Spirifer*) from some Upper Silurian bed . . . . probably Ludlow." These beautiful forms are different from any known to me in the Wenlock shales, and their publica-

* Not similar to his figures, but similar to some cells seen on the specimen of Ulrich's species in my own cabinet.

tion with the above details may be the means of helping others in their researches among the micaceous and other shales of the Ludlow series of rocks. My labours are entirely confined to the Wenlock series and some only of the shales over the Wenlock Limestone.

I do not think it necessary to speak more fully now of the genera *Ascodictyon* and *Rhopalonaria*. It is important, however, in vindication of my remarks, to make some reference to the various opinions on the organisms which Prof. Nicholson gives in the section of his paper entitled " Systematic Position and Affinities " (*l. c.* p. 466). He says, in the first place, that Dr. Strethill Wright (to whom Scotch specimens of *A. radians*, Nich. & Eth., were submitted for examination) " was unable to throw any light upon their nature." Prof. Huxley, to whom the same specimens were submitted, after considerable hesitation, suggested that they might be Protozoa. Mr. H. B. Brady, after a protracted examination of both the Scotch and the American forms, has arrived at the conclusion that they cannot be referred to the Foraminifera. Some of the American specimens (*A. fusiforme*, N. & E., and *A. stellatum*, N. & E.) were kindly submitted by Mr. H. B. Brady to the Rev. Thomas Hincks, who suggested that they were possibly allied to the recent *Anguinariæ*. Neither Prof. Nicholson nor Mr. Etheridge expresses any positive opinion as to their systematic position or affinity. The difficulties encountered by these various authorities when speaking of this remarkable group are valuable so far in helping to establish the uniqueness of the types submitted to them ; but none of the suggestions help to throw light upon their nature and affinity. Yet I have respected the whole of the remarks, and have compared specimens of the fossil species with specimens of every known living type suggested as " probable " by these authors, but without any definite results. Perhaps it would be wise to pause here, for it is not for me to suggest possible affinities when so many experts have failed. Yet I cannot allow the paper to pass out of my hands without making a suggestion, which may possibly share the same fate as the others.

There are not, so far as I am aware, any Cyclostomatous Polyzoa which may be considered as truly stoloniferous. Some of the Hydrozoa are; but I know of none whose stolons are adherent to stone or shell, such as are found in these ancient rocks, neither am I aware that the stoloniferous Ctenostomatous Polyzoa are adherent to stone and shell, like *Ascodictyon* or *Rhopalonaria*. Yet it seems to me that we have, in *Ascodictyon filiforme* at least, primitive representatives of the stoloniferous Vesiculariidæ, such as *Vesicularia* and *Bowerbankia*, or, possibly, some member of the more humble race of the Entoprocta. Barrois has already, in his paper "On the Embryogeny of the Cyclostomatous Polyzoa" (Ann. & Mag. Nat. Hist. Nov. 1882, p. 402), spoken of a pro-Bryozoan race, composed of "free swimming organisms." May *Ascodictyon* be the attached, or larval form, of some of the as yet unknown pre-Upper-Silurian types of organic life, polyzoan or otherwise?

There is, however, another suggestion which may help to throw some little light on the development of *A. radiciforme*, Vine, though we cannot hope by the comparison to explain away all the difficulties which surround the subject. I refer now especially to some remarks contained in a paper by Mr. George Busk, F.R.S., entitled "Notes on a peculiar Form of Polyzoa closely allied to *Bugula*, = *Kinetoskias*, Kor. & Danielssen" (Quart. Journ. Microsc. Soc. vol. xxi. new ser.). After speaking of the development of the various species of *Kinetoskias*, Mr. Busk says, "I have yet scarcely adverted to the most remarkable feature of *Kinetoskias*, viz. the peduncle or stem, which appears to exist in all species. . . . The mode of formation of this part of the zoarium, which is undoubtedly the homologue of the bundle of separate radical tubes so commonly met with among the Polyzoa, is extremely curious and interesting, and, at the same time, in some points as yet more or less obscure, as, in fact, *may be said respecting the mode of formation and development of the more ordinary form of radical tubes* *.

"In the more common forms they are cylindrical, jointed, chitinous tubes, with rather thick walls and with very scanty contents, beyond a few granular particles and irregular threads, representing, as it would seem, the remains of an endosarc, with which, in order that their progressive increase in length, and occasionally complicated branching &c., may be effected, we must suppose the tube to be furnished. In fact it is otherwise impossible, without assuming the presence of a germinal material, to account for the fact that even after the tubes have attained a considerable length the extremity, or a considerable part of the tube, may undergo great changes in form, as is seen in the production of hooks and other means of ensuring adhesion to foreign bodies, changes showing a most extraordinary adaptability to circumstances. Not the least remarkable of these adaptations is the division of the extremity of the tube into a multitude of very minute tubular

* Italics mine.

filaments, each of which may be traced into independent connexion with small foreign bodies." Had Mr. Busk been writing of *Ascodictyon* instead of species of *Kinetoskias*, he could not have given more faithful descriptions of some of the specimens found in the Palæozoic rocks. The suggestive inference to be drawn from these remarks, and others that might have been given, is that the dark brown masses (pulp &c.) in the various species of *Ascodictyon* are probably the remains of endosarc in these once living filaments and semitubular and bulbous tubes.

There is just one other point in Mr. Busk's paper to which I will direct attention in conclusion, because it will help us to understand and appreciate at its proper value *Ascodictyon* and the abortive or "blind cells" of *Rhopalonaria* :—"That the radical and connecting tubes, like the avicularia and vibracula, represent modified zooids, is, I believe, generally admitted; nor can it be denied in this case (*Bugula* &c.) that each successive joint or internode is a distinct zooid." And in a note the author says, "In *Bicellaria* and in *Notamia* it may almost be said that the inhabited part of the zoœcia is simply a dilatation at one part of the internode of a radical tube, which is continued to the ultimate extremity of the branch."

X.—*Descriptions of two new Species of* Walckenaëra, *Blackw.*

By the Rev. O. P. CAMBRIDGE, M.A., C.M.Z.S., &c.

[Plate IV.]

AMONG a large number of Spiders sent to me for identification, during the last three or four years, by Major-General A. W. M. van Hasselt, from Holland, are two of the curious genus *Walckenaëra*, Bl., which I believe to be undescribed. Their discoverer having kindly permitted me to do so, I now subjoin descriptions and figures of these novelties.

Family **Theridiidæ.**

Genus WALCKENAËRA, Bl.

Walckenaëra Hasseltii, sp. n.

Adult male, length $\frac{1}{20}$ of an inch, or $\frac{3}{5}$ of a line.

Cephalothorax rich black-brown.

Legs yellow, tinged with orange-brown. Perhaps in some examples they would be bright orange-yellow.

Abdomen jet-black, thinly clothed with short fine yellowish hairs.

The upper part of the *caput* is slightly raised above the ordinary level, and presents a flattish summit, the middle of which forms an oval distinctly marked by a surrounding groove; the hinder slope or occipital portion looked at in profile is short and abrupt. The profile resembles in this respect pretty nearly that of *W. Beckii*, Cambr., and a not very strong, small, narrow-oval, slightly curved indentation or fovea runs backwards from just above each lateral pair of eyes a little below and parallel with the upper margin of the caput; in the middle of the ocular area are a few short strong upturned hairs. The cephalothorax is short, almost round, and the thoracic region is somewhat flat and its surface rugose, while that of the caput is smooth and glossy.

Eyes small and very indistinct, placed on the fore part of the caput, one pair (the hind centrals) on the anterior edge of the raised portion in a transverse line about a diameter apart from each other; immediately beneath them is a slight transverse indentation, and just below each extremity of it is a lateral pair placed obliquely, and midway between the two lateral pairs (and contiguous to each other) is the fore central pair.

The height of the clypeus is about two thirds of that of the facial space.

Legs slender, not very long nor very unequal in length, 1, 4, 2, 3, furnished with very short fine hairs only.

Palpi short, similar in colour to the legs, excepting the radial and digital joints, which are dark yellow-brown. The radial joint is similar in length to the cubital, but much stronger; it is of a rounded spreading form and has a short bifid apophysis bent abruptly inwards at its fore extremity on the outer side. The digital joint is rather large, oval. Palpal organs highly developed, prominent, with several spines and corneous processes; a very long, slender, filiform spine issues from the middle of their outer side and curves round beneath with a long, free, sinuous, exceedingly slender, hair-like point, and another short black spine is curved in a circular form at their extremity.

Falces small, conical, directed strongly backwards, and of a deep yellow-brown colour.

Maxillæ and *labium* of the ordinary form common to the genus, and similar in colour to the falces.

Sternum large, short, heart-shaped, convex, and of a glossy deep black-brown colour.

An example of this distinct spider, which I have great pleasure in naming after its discoverer, was sent to me in 1880 by Major-General A. W. M. van Hasselt from the neighbourhood of the Hague, Holland. This species appears to be nearly allied to *W. sordidata*, Thor. (*W. atra*, Bl.), a spider I have never seen; but the description of it is not sufficiently close to the spider now described to justify the conclusion that the two are identical. The profile also is much like that of *W. erythropus*, Westr.; but the caput is less elevated and the palpi totally unlike. It is also allied to, but I think quite distinct from, *W. elegans*, Cambr., a Bavarian species (P. Z. S. 1872, p. 766, pl. lxvi. fig. 23).

Walckenaëra nemoralioïdes, sp. n.

Adult male, length $\frac{1}{22}$ of an inch; adult female $\frac{1}{16}$ of an inch.

In size and form, as well as in the coriaceous punctured upper surface of the abdomen, this little spider closely resembles *W. nemoralis*, Bl.; but the colour of the cephalothorax and abdomen is blacker and that of the legs is a clearer yellow than in that species. The two may also be more readily distinguished by the form of the radial joint of the palpi. The apophyses of this joint are in a similar position, but the outer (tapering) one is much larger, longer, and more prominent, being double as long as the joint, slightly curved, projecting outwards at right angles to it, and very slightly hooked at the point. The other apophyses are very similar to those of *W. nemoralis*, but proportionately larger and of a different form, that in front being constricted near the middle.

In *W. nemoralis* the outer apophysis is not only shorter and less strong, but consists apparently of two parts, a basal portion, prolonged and ending with a very fine, sharp, somewhat thorn-like addition.

Examples of this spider have been sent to me at different times during the last two years by Maj.-Gen. A. W. M. van Hasselt from Holland. Mons. Simon, on examining one of these which I forwarded to him, considered it to be only an example of *W. nemoralis*, Bl.; but the differences above noted (as well as some other minor ones) are so constant that I do not feel the smallest doubt of its being specifically distinct. I have received also one example of the typical *W. nemoralis*, Bl., ♂, from Holland; but the species now described has not yet been found in Great Britain.

The female resembles the male in colours, but the occiput is simply a very little gibbous when seen in profile, and the height of the clypeus is rather less than half that of the facial space.

EXPLANATION OF PLATE IV.

Fig. 1. *Walckenaëra Hasseltii.* *a*, spider, magnified; *b*, ditto, in profile, without legs or palpi; *c*, slightly perspective view of caput; *d*, caput, from in front, showing the position of the eyes; *e*, left palpus, from in front and rather inside; *f*, natural length of spider.

Fig. 2. *Walckenaëra nemoralioïdes.* *a*, spider, magnified, ♂; *b*, ditto, in profile, with legs and palpi removed; *c*, caput, from in front, showing the eyes; *d*, left palpus, from in front and rather on the inner side; *e*, radial joint of palpus; *g*, ♀ in profile, without legs or palpi; *h*, natural length of spider; *k*, genital aperture, ♀.

Fig. 3. *Walckenaëra nemoralis*, Bl. Part of palpus of ♂.

XI.—*A second Note on* Pentastomum polyzonum. By F. Jeffrey Bell, M.A.

In the sixth volume of the current series of the 'Annals' (pp. 173–176) I published a short note on the rediscovery of the *Pentastomum polyzonum* of Harley, two female specimens of which had been acquired by the British Museum in 1880. Lately we have received other specimens which formed part of the collection of the late Dr. Edwards Crisp, but are without any indication of origin* and not in first-rate condition.

A short time since an interesting essay on the structure of *Pentastomum* was published by Mr. W. E. Hoyle in the 'Transactions of the Royal Society of Edinburgh' (vol. xxxii. pp. 165–191), in which he describes a new species (*P. protelis*), and gives an account of its anatomy.

Mr. Hoyle was fortunate enough to have examples of both sexes of the parasite, and he describes the male as being 13–17 millim. in length, and as having sixteen or seventeen annuli. Of the two specimens which formed the basis of my former note neither was male; of the seven specimens now received one is a male, and I have been able to observe that it, while measuring 36 millim. in length, has only seventeen rings, and that the most anterior of these are much less prominent than they are in the female. In addition, therefore, to the numerous points of similarity indicated by Mr. Hoyle, we have another in the smaller number of annuli in the male than in the female. Another point is to be observed in the

* Although a careful search has been made in Dr. Crisp's collections, there are no indications of the *Pentastomum annulatum* of Baird, which did, I believe, on the dispersal of the Zoological Society's museum collections, pass into the hands of Dr. Crisp. It is greatly to be wished that this type should be found.

fact that of the six female specimens now before me two have twenty, while the others have only nineteen annuli; in other words, the result to which I was led (*tom. cit.* p. 176), a good deal to my surprise, as to the great value of the number of rings in the body, is a little shaken, although it falls in rather with one's general experience as to the specific value of numbers such as these. It is to be noted, further, that the two females with twenty annuli measured respectively 75 and 80 millim., or less than three with nineteen rings, which measured 90, 95, and 105 millim.; a specimen of 46 millim. in length had nineteen rings.

The fact that the male has seventeen annuli, while that of *P. protelis* has sixteen or seventeen, and the discovery of the fact that the female of *P. polyzonum* is not absolutely limited to nineteen rings, diminishes the gap that separated the two species, Mr. Hoyle being apparently inclined to give as much importance as I did to the seeming constancy of the number of rings in the female.

While these considerations, then, tend to the union of the species *P. protelis* with *P. polyzonum*, the fact that the two animals, the small carnivore and the voracious snake, do live in the same area gives a clenching force which, to my mind, is almost irresistible.

XII.—*The Causes of Variation.* By Romyn Hitchcock*.

The recent studies of Dr. W. B. Carpenter upon *Orbitolites*† are of special interest, owing to the remarkable manner in which the stages of variation and development have been traced. The monograph by Dr. Carpenter, published in the Reports of the 'Challenger' Expedition, was the subject of some remarks recently made by the writer before the Biological Society of Washington, in which an effort was made to explain how such a simple sarcode organism as the animal *Orbitolites* has been led to produce a shell of complex form. Dr. Carpenter regards it as the expression of a not understood "progressive tendency along a definite line towards a higher specialized type of structure in the calcareous fabric." This, however, is merely a statement of the facts observed, and in no wise assists in their explanation. Elsewhere it may be gathered from the author's words that he regards the

* From the 'American Journal of Science' for July 1884, pp. 49–52.
† Phil. Trans. part ii. (1883).

complex shell as significant of a "*plan* so definite and obvious as to exclude the notion of '*casual*' or '*aimless*' variation."

The facts seem capable of a somewhat different interpretation, which seems more in accord with our present knowledge of simple organisms, and quite sustaining the views of Darwin that "plan," in the sense used by Dr. Carpenter, should be superfluous. For if there be an inherent tendency to variation among these organisms, as Dr. Carpenter seems to believe, how do we explain the persistence of the original Orbitoline type, *O. tenuissima*? Biologists seek to discover the causes of variations which they observe; but it seems not less important that the persistence of types should also be explained. *O. tenuissima* is a very ancient species, and surely any inherent tendency to change would have manifested itself during the long period of its existence, even under unfavourable conditions.

The observations I have to offer may be said to relate entirely to change of environment; but their tendency is to demonstrate that the changes observed in the shells of this family are not due to any inherent tendency resulting in a definite plan, but that they are due to causes easily understood.

It is far from my intention to deny a definite plan of growth to these organisms. But plan of growth does not imply that there have been causes acting within the organism—special tendencies of the protoplasm toward higher structure. It seems to be such an assumption that has led Dr. Carpenter to speak of a "not understood" progressive tendency, &c. In my opinion the causes of such progression as can be observed are easily understood; and the plan of growth becomes a natural consequence of these causes, which are purely physiological, and independent of any supposed tendency to variation. While Dr. Carpenter, on the one hand, seems to regard variation as due to an inherent tendency of the protoplasmic body, the writer, on the other hand, attributes it entirely to the more or less favourable conditions of life of the different species. Moreover, I am quite unable to understand how any inherent tendency to variation impressed upon the sarcode could fail to find expression in some differentiation of the sarcode, which in the cases in question has not been observed.

The same view seems to be held by O. Schmidt, who, in his 'Grundzüge einer Spongien-Fauna des Atlantischen Gebietes,' alludes to Dr. Carpenter's previous studies, and compares the changes observed in the Sponges and Foraminifera. He says the changes in the latter are found in the general habit of the form and the variable grouping of the chamber-systems, while among the Sponges the variation is in the microscopic detail. "One may speak of the microscopic form of Foraminifera, but not of microscopic elements."

The complexity of the shell is merely in the multiplicity of chambers and the manner of their intercommunication. The process of growth, even in the complex *O. complanata*, is in all respects identical with that in other species, and in no essential feature differs from that of *Peneroplis*. What Dr. Carpenter designates as a "higher specialized type of structure" does not represent an advanced degree of specialization in any part; nor can we discover any advantage to the organism arising therefrom. It is true there is an advance in complexity; but unless accompanying this there is an evolution in function, or unless it results from some effort of adaptation which confers some benefit upon the organism, it seems not proper to regard complexity of shell-structure as a proof of biological advancement.

Seeking for an explanation of the cause of the increased complexity of shell-structure, so beautifully illustrated in the Milioline family, the writer was led to the conclusion that it is entirely due to the favourable conditions of life and the abundance of food available. It is true, as already said, this may be regarded as a mere statement of the influence of environment causing variation; but a careful consideration of the subject will show that there is a broad distinction between environment as a cause of variation and adaptation to environment; for in this case we are unable to perceive any benefit to the organisms arising from their adaptation to changed conditions.

If it be said we can seldom discover the benefits supposed to be derived from adaptation, it may be answered that it is usually possible to infer how the changes observed may prove beneficial. In the case under consideration, however, an examination of the changes that have taken place does not indicate any possible benefit to the organism. The multiplication of chamberlets necessitates very intimate intercommunication for the transference of food and the continuation of the processes of life. The organism is not thereby better adapted to its surroundings, but is made more dependent for its existence upon the continuance of the favourable conditions under which it has developed. The advance in complexity—the multiplication of chamberlets—would only be possible under the most favourable conditions, for all the nutriment received by the interior segments must be collected by the sarcode at the margin of the shell, and the necessary food could only be obtained where the supply was abundant. It may be conceived that if *O. complanata* were placed in situations less favourable as regards food it would die of starvation, owing to the quantity of inner sarcode requiring nourishment, while *O. tenuissima* needs only more favourable conditions as regards food and, perhaps, temperature to become as highly complex in structure as the last-mentioned species. As a further proof of the influence of environment leading to changes which cannot be regarded as special adaptations, in the usual meaning of the word, the forms of *O. complanata* found on Fiji reef are especially characterized by thick plicated margins, as though growth proceeded with too great rapidity to produce symmetrical disks, and these forms are associated with the largest representatives of the species.

The distinction above referred to seems an important one, which, if it has already been recognized, has not been prominently brought forward in the writings with which I am familiar. Before the Biological Society the subject was briefly considered in the following words:—

"Regarding the subject from this point of view, we are led to examine more closely the relations between the spiral and the cyclical methods of growth. Their intimate relation is only noticeable when we observe how one has been derived from the other. When the spiral growth of *Orbiculina* produces a complete circular disk, further spiral growth becomes impossible; and if we concede that the extrusion of the sarcode to form successive chamberlets is due to nutrition and growth, the cyclical plan then becomes a necessity. In this way it may be supposed cyclical growth originated, purely a result of nutrition, not by adaptation to environment, but as a result of it; not because such growth is or ever was better adapted to the conditions of life.

"We find here a steady course of variation a result of physiological processes, independent of those external causes to which we are accustomed to attribute such changes. These variations, as successively produced, have been perpetuated through inheritance, until the plan of growth has, in some species, totally changed. Herein, therefore, we may find an indication of how the plan of growth originated, and a suggestion that the inscrutable laws which govern the progress of evolution may each have beginnings equally simple, and not beyond the range of human insight to discover. Evolution in this case seems not to be a result of a definite plan of growth, but the plan of growth is the result of physiological processes. However great and important the influences of environment and selection may have been in the production of genera and species, perhaps the attractiveness of the idea and the ease with which it enables us to dimly understand many biogenetic problems permits us to lose sight of other influences more obscure, but of equal importance in the history of life."

This view of the subject seems to derive still further support from the geographical and bathymetrical distribution of the species. Without entering into a lengthy discussion of this part of the subject, it may be said that as a rule the more complex species are found in the warmer waters under conditions most favourable to the activity of nutritive processes. As an example, the very large specimens of *O. complanata* from Fiji reef may be taken. On the other hand, the ancestral form *O. tenuissima* still inhabits the colder and deeper waters, retaining the simple characters of its earliest known condition.

XIII.—*Additions to the present Knowledge of the Vertebrate Zoology of Persia.* By JAMES A. MURRAY.

SINCE the publication of Mr. Blanford's valuable work on the Zoology of Persia (1876), giving a complete list of the animals inhabiting that country, nothing, I believe, has been published as an additional contribution, except a single paper in the Proc. Zool. Soc. for 1881, which added five species to the already large list of reptiles; these are *Agama persica*, *Scincus conirostris*, *Hydrophis temporalis*, *Catachlæna diadema*, and *Hydrophis cyanocincta*, the first three being newly described species.

The Kurrachee Museum, having now rather an extensive collection of Mammals, Birds, and Reptiles from Eastern Persia—very kindly made for the institution by Mr. W. D. Cumming, of the Persian Telegraph, during the past three years—and having also acquired a collection, comprising thirty-six species of Reptiles and seven Mammals (also from Persia)—made, it is said, by a member of some foreign exploring commission in 1876–77—I am enabled, after careful examination of these materials, to add a few more species to the existing knowledge of the Vertebrate fauna of the country.

For the collection said to be made by a member of some foreign commission, the institution is indebted to Mr. Possman, also of the Persian Telegraph. Although this collection dates as far back as 1876–77 the specimens are in an excellent state of preservation; each specimen has been carefully labelled, giving the date, year, and localities of capture, the latter being chiefly Bushire, Tanjistan, and Charbagh, near Bushire.

Among *Mammals* there is nothing new, but a few species, of the occurrence of which Mr. Blanford seemed to doubt and which are comprised in the collection, are noted below.

1. *Rhinolophus ferrum-equinum*, Schreb.

Rhinolophus ferrum-equinum, Schreb., Blf. E. Pers. ii. p. 19.

1 ♂: Bushire, 26. 11. 83.

2. *Ursus thibetanus*, F. Cuv.

Ursus, sp.?, Blf. E. Pers. p. 47.
Ursus gedrosianus, Blf. J. A. S. B. xlvi. pt. 2, p. 317; P. A. S. B. 1879, p. 4.

Mr. Blanford records this from Beloochistan, on the assurance of the natives of the country. Major Mockler very kindly procured for me three skins with skulls of the animal inhabiting the Beloochistan hills. These with two other skins from the Sind hills were those of *Ursus thibetanus*. There is now a live specimen in the Kurrachee Zoological Gardens, from the Sind hills.

3. *Delphinus plumbeus*, Duss.

Not recorded in Zool. E. Pers. The Kurrachee Museum has two skulls from Lingah.

4. *Dipus Blanfordi*, sp. nov.

Dipus macrotarsus?, Wagner, Blf. E. Pers. p. 74.

1 ♂, 1 ♀ adult (pregnant), and two adolescent: Bushire, July 1882.

Four juv.: Tangak, May 1877.

One adolescent, Tanjistan, June 1877.

These agree in every particular with Mr. Blanford's description. The long black tuft of hair beneath the hind feet is very characteristic, also the broad whitish band across the upper part of the thigh and the rufescent fawn thigh-patch. These differences being constant, the Persian form must be considered distinct; and Mr. Blanford having first characterized the species, I have much pleasure in associating his name with it.

I must, however, add the following particulars to the description given by Mr. Blanford:—Mammæ 8—one pair under the throat in front of the fore legs, one pair behind the fore legs, and two inguinal pairs. In adults the tail is unicolorous up to the pencil of hairs and of a pale isabelline colour, while the black portion of the pencil in adolescents is a dark brown, tinged slightly with rufescent; the back is much darker in colour in adults, owing to the bases of the hairs, which are of a dark ash-colour, showing through; claws horny. Molars of upper jaw all biplicate, inside and out: of lower jaw, 1st biplicate on both sides, 2nd triplicate without and biplicate within, 3rd *biplicate outside and rounded* within.

The following are dimensions of an adult pregnant female and an adolescent male:—

	Adult ♀. in.	Adolescent ♂. in.
Length from tip of nose to root of tail	5·25	3·75
Ditto of tail	7·2	6·0
Ditto of pencil at end of tail	0·75	0·56
Total length	13·2	10·31
Height of ear from upper margin of outer conch	0·75	0·5
Ditto from base of skull	0·82	
Breadth of ear laid flat	0·62	0·44
Length of tarsus, foot, and claws	2·62	2·12
Longest whisker (reaching to beyond the axil of the thigh)	3·25	3·0
Skull, from upper edge of *foramen magnum* to end of nasal bones	1·25	
Skull, from lower edge of ditto to front of upper incisors	1·12	
Breadth across hinder part of zygomatic arches	0·87	
Ditto, between orbits	0·5	
Length of lower jaw from condyle to inner base of incisors	0·72	
Teeth-line, upper jaw	0·18	
Teeth-line, lower jaw	0·18	
Space between inner edge of 1st molars	0·18	
Across tympanic bones	0·93	

5. *Dipus Loftusi.*

Dipus Loftusi, Blf. East Pers. p. 75.

1 ♂: Bushire, 6. 12. 83.

1 ♀ juv.: Tanjistan, Nov. 1876.

1 ♀ and four fœtal young: Nov. 1876.

The fœtal young of this species have the whiskers fairly well developed, and the tail is less than half the length of the head and body.

Length of largest specimen (spirit):—

	in.
Head and body	5·37
Tail	6·0
Tarsus, foot, and claws	1·95

6. *Lagomys rufescens*, Gray.

Lagomys rufescens, Blf. East Pers. p. 83.

1 ♂: Bushire, 4. 1. 84.

This agrees well with the description of it by Mr. Blanford, except that the chin, throat, and underparts are a silky yellowish white, as are also the fore and hind feet and the soles of the feet. The longest whisker is white at its extremity, and the lower series of 4–5 white throughout. This is recorded from Afghanistan, Northern Persia, and Mesopotamia, but not from S.E. Persia.

Length 7·5 inches.

Among *Birds* I have to add:—

1. *Falco peregrinator*, Sund.

Falco peregrinator, Sund., Blf. East Pers. p. 103.

Four live *birds* were netted at Bushire and sent to me for the Rev. Mr. Watson, who trained them for the quarry. All belonged to the *atriceps* type.

2. *Circus macrurus*, Gmel.

2 ♂: Bushire.
1 ♂: Fao, Shat-el-Arab.

3. *Hypocolius ampelinus*, Bp.

1 ♂, 1 ♀: Bushire, 13. 9. 83.

According to Mr. Cumming this species passes through Bushire in November. Its range extends N.E. to Fao, on the Shat-el-Arab, as far as at present known, southward to Sind. It breeds in the country. Mr. Cumming and Mr. Betts have taken the eggs at Fao. This is not recorded from E. Persia by Mr. Blanford.

4. *Ardeola leucoptera*.

Several specimens from Bushire. Breeds in June and July.

5. *Sterna fuliginosa*, Gmel.

2 ♀, Bushire, in breeding-plumage, received with ten eggs; and 1 ♀ taken on the Astola Island, S. Persia.

6. *Pelecanus onocrotalus* and *P. crispus*.

Both common in the Persian Gulf. The first has been found breeding at Fao, or rather 50 miles west, on a mud island surrounded by a large marsh, whence Mr. Cumming obtained five eggs.

7. *Phœnicopterus minor*, Geoffr.

A male sent to me from Lingah by a Mr. Belcher, a passenger to Bussorah, with a note to the effect that it was shot out of a flock of larger ones, evidently *P. antiquorum.*

Among *Reptiles* the collection contains several species not recorded from Persia.

1. *Stellio nuptus*, var. *fuscus*.

Stellio nuptus, var. *fuscus*, Blf. East Pers. p. 320.

2 ♂, 1 ♀: Bushire, July 1876.

Mr. Blanford records this from Jalk and Kalagan, in Beloochistan, and not from Persia.

2. *Centrotrachelus Asmussi* *.

Centrotrachelus Asmussi, Strauch, Blf. East Pers. p. 337.

3 ♂: Bushire, July 1883.

Largest specimen 23·5 inches in length. I have had a live specimen since August 1882, still in excellent condition. The animal is extremely lively during the hot hours of the day up to 4 o'clock; after this hour it sleeps soundly, curling itself in a corner of the box in which it is kept. Its means of defence is the spiny tail it possesses, which it lashes like a whip when disturbed. It is extremely fond of having cold water thrown on its body; it then appears much pleased, standing high on its fore legs, with head erect, turning it round, upwards, and looking with each eye, and extending the loose skin of its body to double the usual size. Whether the animal burrows for itself or occupies the burrows of field-rats &c. is a question, as, although it has a foot of soft sand in the box (without a bottom), on the bare ground, it has never yet attempted to burrow.

3. *Hemidactylus Cocteaui*, D. et B.

Three: Charbar, Beloochistan, June 1880.
Two: Charbagh, near Bushire, August 1876.
One: Bushire, August 1883.
Four: Tanjistan, July 1877.

The non-entry of this species by Mr. Blanford is evidently an omission.

* ? *C. loricatus*, Blf. 'Eastern Persia,' ii. p. 340, described from the neighbourhood of Bushire.

4. *Gymnodactylus brevipes.*

Gymnodactylus brevipes, Blf. East Pers. p. 344.

Three: Bushire, Oct. 1883.
One: Tanjistan, Aug. 1876.

This has been recorded from Aptar, near Bampur, in Beloochistan. Mr. Cumming's collection from Bushire contains well-marked specimens of this species.

5. *Gymnodactylus scaber*, Rüpp.

Thirteen: Bushire, June, July, August, 1883.
Seven: Tanjistan, September 1876.

In form the counterpart of *Gymnodactylus petrensis*, Murray (Vert. Zool. Sind, p. 362).

Rostral broader than high and cleft above. Upper labials 10–12; lower labials 8–10. Pupil vertical; first labial and three small shields behind rather smaller than those covering the muzzle; interorbital space and occiput with large conical tubercles interspersed, a few also on the muzzle and a line of 3–4 in front of each eye. Two pairs of chin-shields, the first largest and in contact. Back covered with granular scales and sharply-keeled trihedral tubercles, the latter as large as or slightly larger than the vertical ear-opening, and arranged across the middle of the trunk in 14 longitudinal rows; between the hind limbs the number is six. The tubercles on the sides of the body are rather smaller and subcarinate. Scales across the middle of the abdomen in 18–20 rows. Preanal pores 5–6. Outer surface of limbs with large trihedral tubercles. A pair of tubercles on each side of the sacral region. The fore limb laid forward reaches the end of the snout; laid back it reaches the axil of the hind limb. The hind limb laid forward extends beyond the axil of the fore limb. Tail verticillate, with three rows of sharply-keeled trihedral tubercles on each side to within an inch of the tip, beyond which it is covered with irregularly-arranged imbricate scales. Subcaudals distinct, single, about 44–54; a few of the anterior ones bifid.

Length 4·5 to 5 inches, of which the tail is 2·5 to 2·75.

Colour greyish brown, with three longitudinal rows of dusky subquadrate spots on the back; in some specimens one more row of rather indistinct spots on each side. Tail with 10–12 dark bands above.

Hab. Bushire and Tanjistan, in Persia; Fao, in Southern Mesopotamia, at the head of the Persian Gulf, on the banks of the Shat-el-Arab, and Charbar, in Beloochistan.

Collected by Mr. W. D. Cumming, to whom I am indebted for a large collection of reptiles, fish, &c. from Bushire and Fao, in Southern Mesopotamia.

The synoptical table below will show the differences between this species and the other allied forms of *Gymnodactylus.*

	Dorsal tubercles.	Abdominal scutes.	Pores.		Labials.	
			Femoral on each thigh.	Pre-anal.	Upper.	Lower.
Gymnodactylus caspicus, *Eichwald*	18–20	?	* 32–34		11	8–9
—— brevipes, *W. Blf.*	10	22	......	4	9	7
—— heterocercus, *W. Blf.*	12	25–30	none		8–10	7–8
—— petrensis, *Murray*	12	34–35	......	4	10–12	8–10
—— scaber, *Rüpp.*	14	18–20	......	5–6	10–12	8–10
—— kachensis, *Stol.*	12–14	28–30	* 48		11–12	8–9
—— frænatus, *Günther*	6–8	34	......	4	11	9
—— Oldhami, *Theob.*	30	?	* 40		11	10

6. *Pristurus rupestris.*

Pristurus rupestris, Blf. East Pers. p. 350.

Seventeen specimens from Bushire and Tanjistan, 1876–77.

7. *Ceramodactylus Doriæ.*

Ceramodactylus Doriæ, Blf. East Pers. p. 353.

I have seven specimens of this lizard from Tanjistan, nearly 300 miles further north-east of Bunder Abbas, where Marquis Doria's single specimen was obtained.

8. *Ceramodactylus affinis.*

General form of *Ceramodactylus Doriæ*, but of a more robust habit. The nostril is placed rather behind the outer hind angle of the rostral, instead of immediately above and between the suture of the rostral and first labial. The three shields behind the nostril are flat, *and not distinctly swollen*, as in *C. Doriæ.* The mental is rather of a different shape, having slightly concave instead of straight sides, and a very

* In a continuous line on both thighs.

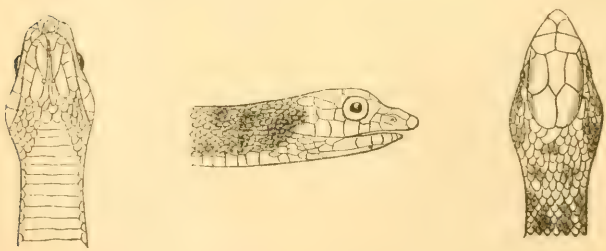
convex hind margin. Upper labials 11, with a number of smaller ones behind, scarcely larger than the granular scales of the tympanic region. Tail not attenuate, as in *C. Doriæ*, but ends rather abruptly; it is three fifths the length of the head and body, while that of *C. Doriæ* is nearly the length of the head and body. The head is short and thick, and presents a very different aspect from that of *C. Doriæ*; its height is about a fifth less than its greatest breadth, or a fifth less than that of *C. Doriæ*, both in height and breadth. The fore and hind limbs are very much stouter and shorter than those of *C. Doriæ*. The fore limb laid forward, the tips of the fingers reach only to the end of the snout, while in *C. Doriæ* the tips of the fingers extend beyond the snout by the length of the foot. The hind limb laid forward does not extend as far as the axil of the fore limb, while that of *C. Doriæ* reaches nearly to the ear-opening. Fingers and toes much shorter and more robust.

Length, head and body 2·62 inches, tail 1·37.

Colour: instead of the spotted character of the markings of *C. Doriæ*, this species is banded, the bands being rather curved, with the concavity in front. There are four bands, one on the occiput, one behind the shoulder, another on mid-trunk, and the fourth on the loins. The tail has 7–8 dark bands. The ground-colour is apparently ochraceous. There are 2–3 dark oblique streaks below the eye along the labials. Sides of the body slightly darker than the back.

Hab. Tanjistan, in Persia. Two specimens among seven of *C. Doriæ*, collected in 1877.

9. *Rhagerrhis productus*, Ptrs.



Head moderate, distinct from neck. Snout rather depressed and produced beyond the mental. Tail short; anal bifid. Eyes rather large; pupil circular; rostral produced, obtuse in front, reverted on to the upper surface of the head, and forming a triangular suture with the prefrontals; below, the rostral is deeply concave. Nasals 2. Nostrils situated in the anterior portion of the postnasal, which is received in the hind, nearly quadrangular, cavity of the prenasal. Loreal 1, square. Preocular 1, reverted on to the upper surface of the head, but not touching the vertical. Postoculars 2. Upper labials 8; lower labials 11, 6 in increasing series from the mental, and 4–5 other smaller ones about the size of the adjoining scales. Sixth upper labial the largest; the fifth under the eye. Mental narrow, angular and pointed behind, slightly convex in front. Mental groove distinct. Two pairs of subequal chin-shields. Two pairs of frontals; vertical elongate, obtusely triangular in front and triangular behind, where it is received in the triangular concavity of the occipitals. Occipitals rounded behind, convex laterally, and longer than their greatest width; temporals variable, generally 2–3 alongside the occipitals, and in some split into small plates. Scales in 17 rows, all, even the head-shields, minutely punctulated with brown (only seen through a Coddington lens). Ventrals slightly angulated.

Colour (spirit-specimens) ochraceous, with equally distributed dusky spots in five rather oblique series. A small dark brown spot under the eye; another less distinct above it (not present in all specimens), a third obliquely behind the eye, followed by a large temporal spot, also oblique, and extending beyond the last labial. Lower parts unspotted, pale yellow.

Hab. Bushire, 1 ♂, 2 ♀; Tanjistan, 3 ♂, 2 ♀.

Length of largest specimen 46 inches, of which the tail is 7 inches; length of smallest specimen 15 inches, of which the tail is 2·5 inches.

10. *Bufo viridis*, Laur.

The following is a description of specimens from Bushire:—

Crown of the head flat, smooth, and devoid of osseous ridges; orbitals elevated and covered with horny-tipped tubercles; interorbital space equal to the width of the eyelid. Hind crown, back, and the upper surface of fore and hind limbs covered with rather close-set horny-tipped tubercles. Parotoids oblong, flattened above about their middle, and separated from each eye by a deep groove. Length of each parotoid equal to the distance between its front edge and the nostril. Tympanum distinct, about one half the size of the eye. Under surface of the body smooth, without any trace of tubercles. Fore feet with a large mesial palmar pad and a smaller one at base of first finger. Laid side by side the first finger is very slightly longer than the second and as long as the fourth; third finger longest. Tarsus with a mesial and lateral longitudinal row of distant tubercles, and a cutaneous fold on the inner side extending to the inner metatarsal tubercle. The tubercle on the outer edge scarcely so prominent as the inner one, which is elongate. Soles of the hind feet faintly tuberculate. Toes half-webbed; the tip of the first reaches the second joint of the second toe. Hind limb long; laid forward alongside the body the metatarsal tubercle reaches the eye, and one half of the foot extends beyond the snout.

Length 3 inches; hind limb from anus to tip of second finger 4·2 inches.

Colour yellowish, a dark spot on each eyelid; another oblique one from the hind edge of the eye to the tympanum, and a third very small one on each nostril; fore and hind legs with 2–4 transverse blotches on their upper surface. Sides of the first and upper surface of first and second fingers black. Under surface pale yellowish. Tips of toes slightly swollen and of a brownish colour.

These specimens come near to *Bufo olivaceus*, Blanf. (East Pers. p. 434, pl. xxviii. fig. 3), but differ from it by having the dorsal surface closely set with horny-tipped tubercles, a flat instead of a concave crown, by its under surface being smooth and not tuberculate, and by its shorter hind limbs. From *B. vulgaris* it is distinguished by its longer hind limbs, having a cutaneous tarsal fold, a distinct tympanum, and no dark band below the parotoid.

XIV.—*Additions to the Reptilian Fauna of Sind.* By James A. Murray.

Since the publication of my work on the 'Vertebrate Zoology of Sind,' a collated descriptive account of all the species of mammals, birds, and reptiles (including several new species) known to inhabit the province, some little interest appears to have been aroused in zoological inquiries, which has resulted in the Kurrachee Museum acquiring several collections of reptiles from hitherto unknown localities in Upper Sind.

Among these are four species from the barren sandy wastes of the frontier districts, collected by my indefatigable correspondent Mr. F. Gleadow, of the Forest Department, three of which I believe are undescribed forms. These are:—

1. *Melanochelys pictus.*

Head two thirds as broad as long, its greatest length 3 inches. It is covered with skin, divided into plates; a long central one above a single broad frontal; a superciliary on each side, and a small subtriangular plate behind in suture with the sides of the central plate. Temples covered with numerous irregular-shaped plates. Upper jaw with a small festoon on each side, the groove in the middle of the jaw rather deep. A plate in front of the eye in suture with the sides of the frontal; another nearly as large under the orbit, and a third about twice the size of the latter behind the eye. Anterior half of neck covered with small subimbricate plates in transverse series. Shell oblong-ovate, elevated, much arched, nearly half as high as long, nodosely tricarinate, the costal carina being much nearer the vertebral carina than the marginal plates. Length of shell over curves 14 inches; breadth over vertebrals 11·75 inches. The sternum is bent upwards from the suture of the pectorals with the postgulars; greatest length of sternum to point of furcate projection of anal plates 12 inches. Anals deeply notched posteriorly, the distance between the projecting ends being 1·5 inch and the depth of notch 1·37 inch. Width of sternum at axillary incision 6 inches, at inguinal 4·75. Gulars together broader than long, their hind margin received into the subtriangular concavity in front of the postgulars, which are as broad as long. Pectorals very narrow, each $3 \times 1{\cdot}5$ inches, the suture between them about equal in length to that of the postgulars and slightly more than half of that of the abdominals. Abdominals nearly rectangular, winged beyond the inguinal incisions, and forming a suture on each side with the inguinal plate and sixth marginal. Postabdominals longer than broad, the length of their suture together slightly less than that of the abdominals; transverse sutures of postgulars with abdominals and abdominals with postabdominals straight; suture of postabdominals with anals concave; the suture together of the anal plates is shorter than the suture of a single one with the postabdominal. Nuchal plate oblong ($0{\cdot}75 \times 0{\cdot}5$ inch). Vertebrals hexagonal; first somewhat bell-shaped, convex in front, straight behind (except a concavity mesially to receive an apophysis of the second vertebral), sinuately concave on each side in its anterior half and convex lower down. Second and third vertebrals hexagonal, as broad as long; fourth similar, but concave behind in suture with the convex front of the fifth, which is about twice the size of the other vertebrals, broader than long (2·37 × 3·37 inches), with the sides sloping outward to the last marginal; its suture with the caudals is straight. Caudal notched, the suture of both plates a little more than half the length of the fifth vertebral. Tail short, 1·5 inch in length. Costals large, four in number, nodosely carinate on their upper margin, but not extending, or scarcely seen on the fifth vertebral. The first costal is subtriangular and largest, convex in front, in suture with one half of the first and the whole of the upper margin of the second, third, and fourth marginals; second costal in suture with the fifth and sixth marginals, its greatest breadth about two thirds its greatest length (4 × 2·75 inches); third costal in suture with the seventh, eighth, and anterior third of the ninth; it is nearly the size of the second in length and breadth; fourth costal smallest and forming sutures with the posterior two thirds of the ninth marginal, entire tenth, mesially the apex of the eleventh, and the sides of the fifth vertebral. Marginals variable in size, not serrated posteriorly, but slightly dilated at the eighth, ninth, and tenth. Feet anteriorly covered with imbricate scutes, posteriorly, or higher up, subimbricate, the scutes much smaller. Toes short, strong, and webbed to the claws; they are covered with annular scute-like plates. Claws strong and hooked. Sides of the legs fringed with large scales. Colours: all the scales on the tarsi and feet with a yellow spot. Head black, with large spots, blotches, and streaks of yellow; a patch on each side of the snout, also on each side of the nostrils; one under each eye, another at the maxilla on the labial margin, and two behind each eye. There are also some large blotches on the tympanic and temporal regions, and three on each side of the lower jaw. Shell olive or greenish brown, the marginals, lower part of costals, and vertebrals with pale yellowish blotches and streaks of irregular shape. Sternum pale yellow, with linear transverse lines, very close together on the abdominal plates, and forming a large patch. The gulars and postgulars are not marked.

Mr. Gleadow, obtained this species in the Sind "*Doro,*" in the Kushmore Talooka, Upper Sind.

It differs from all the described forms of *Melanochelys*, first by its greater size, next by the size and shape of the vertebrals and costals, and lastly by the markings of the shell and the spotted character of the head and feet.

2. *Hemidactylus kushmorensis.*

Head rather depressed. Rostral grooved above, slightly wider than high. Upper labials 10; lower labials 8. Two pairs of chin-shields, the first only in contact. Muzzle covered with granular scales. Nostrils between the rostral, first labial and three small shields behind about equal in size to those covering the muzzle. Crown of the head interspersed with numerous rounded tubercles. Back with rounded tubercles arranged in twenty-two longitudinal series across the middle of the body; a few tubercles between the hind limbs are subtrihedral. Tail verticillate, each verticil armed laterally with three rows of rather elongate subtrihedral tubercles, except on its posterior third, where they are replaced by imbricate scales. Fore and hind limbs on their upper surface studded with round tubercles. Toes covered with imbricate scales. Claw on thumb well developed. Scales on the throat about one third the size of those on the abdomen, across the middle of which they are arranged in 32–36 longitudinal series; the anterior half irregularly and minutely 1–3 crenulate, less conspicuous on the posterior half.

Femoral pores 10–12 on each thigh. Under surface of tarsi covered with large imbricate scales. Subcaudals single, 44–46. Middle toe with six pairs of plates and an odd one at each end.

Colours neutral grey or brown, with three rows of squarish dark blotches, forming either longitudinal or obliquely transverse interrupted bands; a few smaller spots on the sides. A dark streak through the eye with a pale line above it. Scales on the under surface of the body freckled with 1–3 dark spots; many, especially on forward part of body, without them. Tail with 14–15 dark bands. Pupil vertical.

Hab. Upper Sind, Kushmore and Thool Talookas.

Two only of six specimens with unreproduced tails. Length 4 to 4·25 inches. Type from Bhaner, Upper Sind frontier.

Differs from all the other species of the genus in having a greater number of dorsal tubercles, also femoral pores, except *H. Gleadowi*, and fewer abdominal scutes, except *H. triedrus*, and in having rounded tubercles.

The following Table will sufficiently show the differences between it and the other allied species of the genus :—

Species.	Dorsal tubercles.	Abdominal scutes.	Pores.		Labials.		Length in inches.
			Femoral on each thigh.	Preanal.	Upper.	Lower.	
Hemidactylus Gleadowi, *Murray* (V. Z. Sind)	15–16	38–39	13	......	10–12	8–10	4·25
H. karachiensis, *Murray* (V. Z. Sind)	16	38–40	......	6	9–10	8–10	3·5 to 4
H., sp., *Blanford* (E. Persia)	14	40	none		10	8–9	3·65
H. persicus, *Blf.*	16	42–44	......	8	11–12	9	5
H. kushmorensis, sp. nov.	20–22	32–36	10–12	......	9–10	8	4·25
H. subtriedus, *Jerd.**	18–20	?	8	......	7	......	7
H. triedrus, *Daud.**	Numerous.	30	7–8	......	9–10	8	7
H. maculatus, *D. et B.**	do.	37–41	10–14	......	11	8	5
H. Pieresi, *Kelaart**	do.	40–42	32–36†		11–12	10	9
H. gracilis, *Blanford**	do.	?	......	6	?	?	?

3. *Gymnodactylus scaber*, Rüpp.

Two specimens collected at Sukkur and one at Laki, between Shikarpoor and Sukkur, by Mr. F. Gleadow (see my preceding paper, "On Additions to the Fauna of Persia," for description of this species).

It replaces *Gymnodactylus petrensis* in Upper Sind.

4. *Acontiophis paradoxa.*

Acontiophis paradoxa, Günth. Proc. Zool. Soc. 1875, p. 232.

This snake was known from a single specimen only, the locality of which has only now been ascertained. I count ventrals 180, and subcaudals 52. My specimens are greyish brown; a dark line from behind the eye to the nape, a subovate dark patch on the occiput and a border along the margins of the occipitals from the anterior half of the superciliaries. A dorsal series of quadrangular dark spots with white interspaces, nearly of the same width to within an inch of the end of the tail, where they become smaller and more faint, and gradually disappear.

Total length of larger of two specimens 14·25 inches, of which the tail is 2·10 inches.

* From Günther and Theobald's works on Reptiles of Br. Ind.

† In a nearly continuous line.

Hab. Upper Sind, Thool Talooka, at Zungipoor, frontier districts.

Mr. F. Gleadow states that the two specimens of this snake were dug up from depressions a quarter-mile apart in a considerable area of blown sand forming hillocks 20 to 30 feet high.

XV.—*On a new Species of* Lycopodites, *Goldenberg* (L. Stockii), *from the Calciferous Sandstone Series of Scotland.* By R. Kidston, F.G.S.

[Plate V.]

The genus *Lycopodites*, as originally employed by Brongniart* and most of the older writers, did not contain any plant which was really entitled to the name, in so far as it was used to infer their closer affinity to the recent *Lycopodium* than that held by the genus *Lepidodendron*; and Brongniart, in his later writings, discarded his genus *Lycopodites*, as subsequent investigations had shown him that his original view of the plants he included in it was founded on an erroneous notion of their true nature†.

Hence, when Goldenberg resuscitated the genus *Lycopodites*, it was used by him in an entirely different sense from that to which it had been applied by previous writers, and in fact was a new genus though under an old name.

To enable us more clearly to appreciate the light in which Goldenberg regarded his genus *Lycopodites*, I quote his introductory remarks regarding it.

Lycopodites, Goldenberg. 1855‡.

"Branches with leaves placed spirally or in verticils. Sporangia placed in the axils of the leaves or forming terminal cones."

"In the genus *Lycopodites* we place the true herbaceous Lycopods of former ages, which agree in all essential points so exactly with recent Lycopods that, at the most, they can only be regarded as a subdivision of the genus *Lycopodium*.

"The fossil plants included by Brongniart and others under this name are probably only young twigs of *Lepidodendron*

* 'Prodrome,' p. 83 (1828), and 'Classification des végétaux fossiles,' p. 46 (1822).

† Tableau d. genres de Végét. foss. p. 40 (1849).

‡ 'Flora Saræpontana Fossilis,' Heft i. pp. 9, 10 (1855).

or Coniferæ. This view, which we here accept, has been pointed out by Brongniart in his last work ('Tableau des genres de végéteaux fossiles, considérés sous le point de vue de leur classification botanique et de leur distribution géologique'), and is thus stated by him:—

"'The plants really analogous to the recent Lycopods are very few in number in the fossil state.

"'I do not know even one which, by its dimensions and the disposition of its leaves, may be compared with certainty to the species of the genus *Lycopodium* properly so called; the greater part of the plants which I have designated or which have been indicated as *Lycopodites*, are probably either the upper portions of young branches of *Lepidodendron* or the branches of Conifers.

"'Thus the greater part of the *Lycopodites* with dichotomous branches from the Carboniferous formation appear to belong to the first class; those species with distichous pinnate branches evidently belong to Conifers of the genus *Walchia*. The greater part of the species from more recent formations, as the Lias and Oolite, belong to this latter group; such are in particular *Lycopodites Williamsonis* and *patens*.

"'Among these there is, however, one species, which has all the characters of a Lycopod, or perhaps more the character of the genus *Selaginella*. This, the *Lycopodites falcatus*, L. & H.*, has lately been rightly separated, and from its delicate and dichotomous branches, apparently distichous leaves (but which are probably opposite and unequal), has all the appearance and essential characters of the numerous species of the genus *Selaginella*.

"'I know no species which resembles the true Lycopods, as at present defined, nor the genus *Tmesipteris*.'

"We have therefore in *Lycopodites* the addition of a new genus of fossil plants to the Carboniferous flora, which, according to Brongniart, is at present only known by one species from the Oolitic formation of England†. For the plant-remains which hitherto have been described and figured from the Carboniferous formation under the name of *Lycopodites Bronnii*, *longifolius*, &c., belong, as we have seen, to quite other genera of plants, as they do not exhibit any of those points which form the principal characteristics of club-mosses.

"Many years ago I found plant-impressions in the Carboniferous rocks of this neighbourhood (Saarbrück) which, in the character of their growth, showed a great similarity to our herbaceous Lycopods. At the Meeting of the Natur-

* 'Fossil Flora,' pl. lxi.

† *Lycopodites falcatus*, L. & H.

historischen Vereins der preussischen Rheinlande at Kreuznach I exhibited a pretty complete example, and also later, in the Transactions of this Society, made some preliminary remarks on the occurrence of such plants in the Carboniferous formation. I succeeded later in discovering several other species, of which some even bore distinctly their organs of fructification. It then appeared that, as regards the position and form of the fruit, these fossil remains agree completely in all essential points with our living Lycopods.

"The *Lycopodites* which we are about to describe may, like our recent club-mosses, be placed in two subdivisions, according to whether the sporangia are seated in the axils of the leaves or form terminal cones."

The six species described by Goldenberg are classed under these two heads :—

A. Sporangia placed in the leaf-axils.

1. *Lycopodites denticulatus*, Goldenberg.
2. —— *elongatus*, Gold.

B. Sporangia forming terminal cones.

3. *Lycopodites primævus*, Gold.
4. —— *leptostachyus*, Gold.
5. —— *macrophyllus*, Gold.
6. —— *taxinus*, L. & H., sp.

In regard to his last-mentioned species, which he identifies as *Knorria taxina*, L. & H., its claim to belong to the genus *Lycopodites* rests on very slender grounds.

His figure only shows a small portion of a stem 1½ inch long and about ¼ inch wide, with spirally arranged leaf-scars, in general form very like those of *L. Stockii* (Pl. V. fig. 1) ; but this single character, as shown in Goldenberg's figure, appears of too little importance to be of generic value.

But apart from the question as to the systematic position of Goldenberg's *L. taxinus*, it is clearly not the same fossil as that named *Knorria taxina* by Lindley and Hutton.

The specimen, from which the last-mentioned author's plate is taken, is preserved in the "Hutton collection," Newcastle-on-Tyne. This I have compared with their figure, which, I am sorry to say, is not a very correct representation of the fossil. I believe Lindley and Hutton's plant is merely a small stem of *Cordaites*, certainly a quite different plant from Goldenberg's *Lycopodites taxinus*.

In the same year (1855) in which Goldenberg described his specimens, Geinitz figured and described another species, *Lycopodites Gutbieri**.

All these plants Schimper has placed in the recent genus *Lycopodium*†. Both Goldenberg and Geinitz considered them, if not identical with *Lycopodium*, extremely closely related to that genus.

Schimper's opinion of the systematic position of these plants has been adopted by Renault‡, who has described a small Lycopodiaceous stem under the name of *Lycopodium punctatum*§; another, in the same communication, is described by Ad. Brongniart as *Lycopodium Renaultii*.

Both these small stems, though perhaps closely related to *Lycopodium*, possess some structural differences which we are inclined to regard as of sufficient importance to exclude them from the recent genus in which they are placed.

Renault, in his very interesting paper, has pointed out the presence of areolated vessels in his fossils, which he admits do not occur in recent *Lycopodium*. It is quite possible that the specimens described by Renault and Brongniart are stems of plants similar to Goldenberg's *Lycopodites*; but as they are not identical in structure with any known *Lycopodium*, I think it better to place them in *Lycopodites* than in *Lycopodium*.

The same train of reasoning inclines me to reject the genus *Lycopodium* for Goldenberg's species, notwithstanding their undoubted close relationship to it. If we place them in *Lycopodium*, we commit ourselves to the opinion that the fossils are identical in all essential structural peculiarities with their recent representatives—an opinion not at present satisfactorily substantiated by proof. I therefore propose to reinstate the genus *Lycopodites*, Goldenberg, for the following species:—

A. Sporangia placed in the axils of the leaves.

1. *Lycopodites denticulatus*, Gold.
2. —— *elongatus*, Gold.

B. Sporangia forming terminal cones.

3. *Lycopodites primævus*, Gold.
4. —— *leptostachyus*, Gold.

* 'Die Versteinerungen der Steinkohlenformation in Sachsen,' p. 32, pl. i. fig. 1 (1855).

† Schimper, Traité d. paléont. végét. vol. ii. p. 8, pl. lvii. (1870).

‡ Cours d. botan. foss. p. 74, pl. xii. figs. 9, 10 (1882).

§ Ann. des Sciences Naturelles, 5e sér. Bot., vol. xii. pp. 178–182, pls. xii.–xiv. (1869).

5. *Lycopodites macrophyllus*, Gold.
6. —— *Gutbieri*, Göpp. (=*L. stachygynandroides*, Gutbier).
7. —— *Stockii*, Kidston, n. s.

C. Sporangia unknown.

8. *Lycopodites punctum*, Renault, sp.
9. —— *Renaultii*, Ad. Brong. sp.
10. (?) —— *taxinus*, Gold. (not L. & H.).

The above list contains all the plants, as far as I am aware, which are entitled to be placed in *Lycopodites*, Goldenberg; but since Brongniart and Goldenberg wrote on this subject, notwithstanding the warnings given by these two authors, many Lepidodendroid twigs have been figured and described as *Lycopodites*. Most of these belong, I believe, to *Lepidodendron Sternbergii* and *Lep. rimosum*, and probably to other species of the same genus.

I have seen specimens of these two *Lepidodendra* with small delicate branches springing from stems of considerable size, which could be specifically identified with described species of *Lycopodites*. These small lateral branchlets are merely the result of very unequal dichotomy*.

Whatever view may be taken of these Lepidodendroid twigs, or so-called *Lycopodites*, it will, I think, be admitted on all hands that they do not find a suitable place in Goldenberg's genus *Lycopodites*.

Lycopodites Stockii, Kidston, n. s.

Description. Cone terminal, composed of a number of oval sporangia; leaves arranged in whorls, dimorphic (?), the larger leaves ovate-cordate, acuminate with a strong central midrib, the (?)smaller leaves transversely oval.

Remarks. The specimen from which the above description is taken, is about 4 inches long; of this, the cone, which is imperfect at its apex, occupies $1\frac{1}{4}$ inch. The leaves are mostly displaced, but the form of many of them is well shown.

Unfortunately the state of preservation of the fossil is not all that could be desired; but it is sufficiently distinct to enable one to give a description by which it can easily be recognized.

In Pl. V. fig. 1 is given a careful sketch of the plant. The cone consists of a number of oval bracts: some of them appear reniform in shape, but the fossil is so much compressed that the individual contour of the sporangia

* As an example, I give on Pl. V. fig. 5, some small branchlets of *Lepid. rimosum* from the Upper Coal-measures, Timsbury, Somerset.

cannot be well made out. The leaves shown on the sides of the stem are ovate acuminate, with a very distinct middle nerve (fig. 2).

An interesting point in the fossil is the occurrence of a vertical row of curiously formed leaves (?), entirely different from those just described. One of these (*a*, fig. 1) is shown enlarged at fig. 3. This curious structure has very much the appearance of a sporangium ; but the occurrence of a terminal cone and of sporangia situated in the axils of the leaves of the same species, is altogether unknown in any Lycopod, either fossil or recent.

The most perfect of these curious structures (whether leaves or sporangia) appears to have three inflations (fig. 3) ; but I am rather inclined to think that this appearance has been caused by its being pressed against the stem, and that we have under consideration a leaf and not a sporangium. In this case we have merely a dimorphic condition of leaves, such as occurs in those fossils already described by Goldenberg and Geinitz, and is common in the recent genus *Selaginella*. In this example, in no case are they exhibited so clearly that one can positively affirm they are leaves ; but I believe this to be their true nature notwithstanding their sporangium-like form. In the enlarged sketch (fig. 3) the dark dentate margin has no connexion with the supposed leaf, but only a small broken piece of carbonaceous matter, which probably represents the cortex.

The leaves appear to have been arranged in whorls of 6 or 8, as shown by the cicatrices on the enlarged portion of the stem (fig. 4).

My thanks are due to Mr. T. Stock, Edinburgh, who has submitted this fossil to me for examination and description, and after whom I have pleasure in naming it.

I believe the opinion generally current regards the genus *Lepidodendron* as the ancestor of our herbaceous Lycopods ; but I am rather inclined to believe that the genus *Lepidodendron* has entirely disappeared, and that our recent Lycopods are the descendants of Goldenberg's *Lycopodites*.

Horizon. Calciferous Sandstone series (Culm of Stur).

All the species of *Lycopodites*, Goldenberg, previously described have been derived from the Coal-measures ; hence the discovery of the genus so far down in the Carboniferous formation is of considerable interest.

Locality. Glencartholm, Eskdale, Dumfries.

EXPLANATION OF PLATE V.

Fig. 1. *Lycopodites Stockii*, Kidston, n. sp., nat. size: *a, b, c, d, f.* Sporangium-like leaves (?); *e.* Reniform sporangia of terminal cone.
Fig. 2. Leaf, enlarged, seen on fig. 1, *g.*
Fig. 3. Sporangium-like leaf (?), enlarged, seen on fig. 1, *a.*
Fig. 4. Small portion of stem, enlarged, showing leaf-cicatrices.
Fig. 5. *Lepidodendron rimosum*, Sternberg.

XVI.—*Synopsis of the Families of existing Lacertilia.* By G. A. Boulenger.

Whilst engaged in a revision of the Lizard-collection in the British Museum, I have felt the necessity of a thorough systematic rearrangement of the order Lacertilia. The classifications proposed by Duméril and Bibron and Gray, and now still generally in use, with slight modifications, are, on the whole, as unnatural as can be, and founded to a great extent on characters of pholidosis and physiognomy. Physiognomy is worth nothing as a guide in the formation of higher groups; as to the characters afforded by the scales I have convinced myself that they are very deceptive, and ought to be taken into consideration in the definition of families only when accompanied by other characters. Like Cope, whose lizard-families * I regard as the most natural hitherto proposed, I shall lay greater stress on osteological characters and on the structure of the tongue. Special importance must also be attached to the presence or absence, and the structure, of dermal ossifications on the head and body, and these will be found to correspond with many other characters. Bocourt †, to whom is due the merit of having pointed out their systematic importance, did not realize the very great progress made by means of that character, the modifications of which he so ably illustrated, for he still maintains the artificial group Scincoïdiens, in spite of the objections of Cope, whose views are evidently confirmed by the researches of the French herpetologist.

The order Lacertilia, as restricted by Günther ‡, may be divided into two primary groups only, the Chamæleons on the one hand, and all the other Lizards on the other. The Amphisbænians, which by nearly all recent authors are sepa-

* Proc. Acad. Philad. 1864, p. 224, and Proc. Am. Assoc. Adv. Sc. xix. 1871, p. 236.
† Mission Scient. Mexique, Rept. p. 476 (1881).
‡ Phil. Trans. Roy. Soc. clvii. 1867, p. 625.

rated as a suborder, or even as an order, I include among the true lizards, and regard them as a degraded type of the Teiidæ, with which they are to some extent connected by the Chalcides and their allies. The principal characters which have been put forward in favour of their separation are :—(1) absence of interorbital septum ; (2) absence of columella cranii ; (3) very short mandible, causing the quadratum to be nearly horizontal ; (4) division of the occipital condyle ; (5) absence of postorbital and fronto-squamosal arches; (6) absence of scales. These characters, which are mostly negative, are not all constant throughout the group, and many will be found, to a greater or less degree, to be characteristic of all strongly degraded, burrowing forms, such as *Aniella* near the Anguidæ, *Anelytrops* (*Typhline*) and *Dibamus* near the Skinks, &c. The importance of these characters justifies our placing the Amphisbænas in a separate family ; but, in my opinion, not in a higher group, for the following reasons :—

1. The absence of interorbital septum also occurs in *Ophiognomon* among the Teiidæ, and there is every gradation between the skull of that genus and that of higher members of the same family : besides *Aniella* and *Dibamus*, which belong to totally different families, also possess the same negative character.

2. The columella disappears gradually with the interorbital septum ; it is hardly distinguishable in *Ophiognomon* and totally absent in *Aniella* and *Dibamus*.

3. The aberrant lower jaw, not in itself a very important character, is not even constant, the genus *Blanus* differing in that respect as much from the typical *Amphisbæna* as from a typical Lizard.

4. The division of the occipital condyle, also a character the importance of which ought not to be exaggerated, is not even constant, the Acrodont Amphisbænians forming exceptions.

5. The absence of postorbital and fronto-squamosal arches, which occurs in the most diverse groups of Lizards, cannot be regarded as more than a family character.

6. The naked integuments (if we may apply this term to the skin of the Amphisbænians with its soft scales) are not special to the group, but occur also in Geckos ; and they are so closely approached by those of some Cercosaurine and Chalcidine Teiidæ as to render any sharp distinction impossible.

On the other hand, characters such as are afforded by the tongue, which in all Amphisbænians is in every respect similar to that of the Cercosaurine and Chalcidine Teiidæ, the preanal pores of most Amphisbænians, and the anterior limbs of *Chirotes* are indicative of affinity to the Teiidæ. Respecting the latter, it may be remarked that in the other Lacertilia which dispense with the limbs, the fore pair disappear before the hind pair, and this holds true for the Ophidians, the less modified type still showing rudiments of pelvis, whilst not one preserves any thing of the pectoral arch. A reverse process obtains in the Teiidæ and Amphisbænidæ.

I have already put forward my objections to recognizing the suborder Nyctisaura*.

Having separated the Chamæleons, we are in presence of the large suborder of true Lizards. This I have divided into twenty families, which I regard as perfectly natural groups. But there is great difficulty in arranging these families in a line. Two characters seem to demand special attention—those of the lingual papillæ and the clavicle, as, excepting the Geckos and Eublepharidæ, they exactly correspond, *i. e.* the forms with smooth or villose tongue have a slender, non dilated clavicle, whereas those with scaly tongue have the clavicle strongly dilated proximally and generally enclosing a foramen.

Order **LACERTILIA.**

Suborder I. LACERTILIA VERA.

A. *Tongue smooth, or with villose papillæ; clavicle dilated, loop-shaped proximally; no postorbital or fronto-squamosal arches.*

Fam. 1. Geckonidæ. Vertebræ amphicœlian; parietal bones distinct.
Fam. 2. Eublepharidæ. Vertebræ procœlian; parietal single.

B. *Tongue smooth or with villose papillæ; clavicle not dilated proximally.*

Fam. 3. Uroplatidæ. Vertebræ amphicœlian; interclavicle minute; no postorbital or postfronto-squamosal arches.

Fam. 4. Pygopodidæ. No postorbital or postfronto-squamosal arches; pre- and postfrontal bones in contact, separating the frontal from the orbit.

Fam. 5. Agamidæ. Postorbital and postfronto-squamosal arches present; supratemporal fossa not roofed over by bone; tongue thick; acrodont.

Fam. 6. Iguanidæ. Postorbital and postfronto-squamosal arches present; supratemporal fossa not roofed over by bone; tongue thick; pleurodont.

Fam. 7. Xenosauridæ. Postorbital and postfronto-squamosal arches present; supratemporal fossa not roofed over; anterior portion of tongue retractile.

Fam. 8. Zonuridæ. Postorbital and postfronto-squamosal arches complete; supratemporal fossa roofed over; tongue simple.

Fam. 9. Anguidæ. Postorbital and postfronto-squamosal arches present; supratemporal fossa roofed over; body with osteodermal plates

* Ann. & Mag. Nat. Hist. (5) xii. 1883, p. 308.

with irregular, arborescent, or radiating channels; anterior portion of tongue retractile.

Fam. 10. Aniellidæ. No interorbital septum, no columella cranii, no arches.

Fam. 11. Helodermatidæ. Postorbital arch present, postfronto-squamosal arch absent; pre- and postfrontals in contact, separating the frontal from the orbit.

Fam. 12. Varanidæ. Postorbital arch incomplete; postfronto-squamosal arch present; supratemporal fossa not roofed over; nasal bone single; tongue deeply bifid, sheathed posteriorly.

C. *Tongue covered with imbricate scale-like papillæ or with oblique plicæ; clavicle dilated proximally, frequently loop-shaped.*

Fam. 13. Xantusiidæ. Parietals distinct; postorbital and postfronto-squamosal arches present; supratemporal fossa roofed over.

Fam. 14. Teiidæ. Postorbital and postfronto-squamosal arches present; supratemporal fossa not roofed over; no osteodermal plates.

Fam. 15. Amphisbænidæ. No interorbital septum; no columella cranii; no arches; premaxillary single.

Fam. 16. Lacertidæ. Arches present; supratemporal fossa roofed over; premaxillary single; no osteodermal plates on the body.

Fam. 17. Gerrhosauridæ. Arches present; supratemporal fossa roofed over; premaxillary single; body with osteodermal plates with regular channels (a transverse one anastomosing with perpendicular ones).

Fam. 18. Scincidæ. Arches present; premaxillary double; body with osteodermal plates as in the preceding.

Fam. 19. Anelytropidæ. Premaxillary single; no arches; no osteodermal plates.

Fam. 20. Dibamidæ. Premaxillary double; no interorbital septum; no columella cranii; no arches; no osteodermal plates.

Suborder II. RHIPTOGLOSSA.

Fam. 21. Chamæleontidæ.

The *Geckonidæ* and *Eublepharidæ*, which differ from all other families in combining a dilated clavicle with a simply papillose tongue, are well distinguished from each other by the vertebræ, which are amphicœlous in the former and procœlous in the latter. As characters of minor importance may be mentioned the coossification of the parietal bones in the Eublepharidæ, while they remain distinct in the Geckonidæ, which are also distinguished, constantly I believe, by having one bone less in the mandible, the supra-angulare having coalesced with the angulare.

Next come the *Uroplatidæ*, which are now for the first time separated from the Geckos. Although agreeing in most respects with the latter, their sternal apparatus differentiates them widely; the clavicle is slender, not at all dilated, and the interclavicle is reduced to a minute bone. Except the chamæleons, all other lizards in which the pectoral arch is not rudimentary have a large interclavicle. To this very important character is added another; the nasals are united into a single bone, a peculiarity which is found elsewhere only in the Varanidæ among recent lizards. A single genus, *Uroplates*, from Madagascar, is known.

After the Uroplatidæ I have placed the *Pygopodidæ* (= Pygopidæ + Aprasiadæ + Lialisidæ of Gray), which family is now based on new characters. They were formerly arranged with or near the "Scincoids," a view which cannot be maintained, since that group was an assemblage of forms having totally different affinities, and "Scincoids" will now be found scattered through the following families:—Anguidæ (*Anguis*, *Diploglossus*, &c.), Aniellidæ, Teiidæ (*Gymnophthalmus*, &c.), Scincidæ, Anelytropidæ, and Dibamidæ. The skull of the Pygopodidæ in its simplicity of structure approaches that of the Geckos, and the parietal bones remain distinct in all the genera except *Lialis*; the bones of the lower jaw are still more reduced in number, the angular, supra-angular, and articular having coalesced, a character by which they approach the snakes. The affinities of this little group are very obscure, and a complete investigation of their anatomy is highly desirable.

The two closely allied families *Agamidæ* and *Iguanidæ* remain as before.

The *Xenosauridæ* must be regarded as intermediate between the Iguanidæ, with which Peters was inclined to associate them, and the Anguidæ, near which they are placed by Cope.

The *Zonuridæ* correspond only in name with the Zonuridæ of Gray and most other authors. The members of Gray's Zonuridæ will be found in the following families:—Anguidæ (*Gerrhonotus*, *Pseudopus*, &c.), Lacertidæ (*Tachydromus*), Gerrhosauridæ. They have, like the Anguidæ, a villose tongue, though not retractile at the end, a slender clavicle, and in some the body even presents bony plates, which are destitute of symmetrical canals. As here understood, the Zonuridæ comprise the genera *Zonurus*, *Platysaurus*, and *Chamæsaura*.

The *Anguidæ* correspond to Cope's Anguidæ and Gerrhonotidæ, the differential characters of which latter group seem to me insufficient for family separation. As Cope has shown, this group is perfectly natural, though containing "Chalcidoid" and "Scincoid" forms, and an excellent illustration of how misleading it is to trust only to external characters. The "Scincoid" forms correspond to Bocourt's Diploglossidæ.

The family *Aniellidæ* was also established by Cope. I would regard it as a degraded form of the Anguidæ.

The *Helodermatidæ*, as already shown by Cope, have the greatest affinity to the Anguidæ, from which they are, however, well distinguished by the structure of the skull. The grooved teeth might be given provisionally as another family character. It would be highly important to have some information on the osteological characters of Steindachner's Lanthanotidæ, as there is reason to suspect they will enter this family.

The *Varanidæ*, which come last in the series of alepidote-tongued lizards, remain characterized as before, and form a perfectly isolated group.

We have next a series of families characterized by the peculiar scale-like lingual papillæ and the proximally dilated clavicle.

The *Xantusiidæ* are closely allied to the Teiidæ, but distinguished by the different skull and scarcely incised tongue.

The *Teiidæ* form a very natural group, comprising the Cercosauridæ, Chalcididæ, Chirocolidæ, Anadiadæ, and part of the Gymnophthalmidæ of Gray and the Tretioscincidæ of Bocourt. It thus contains "Lacertoid," "Chalcidoid," and "Scincoid" forms of the Dumérilian system, all passing into one another by insensible gradations and all agreeing in the structure of the skull, tongue, and pectoral arch. All are confined to the New World, whereas the analogous family *Lacertidæ* is restricted to the Old World. As mentioned above, I regard the Amphisbænidæ as strongly degraded forms of the Teiidæ.

I establish a family *Gerrhosauridæ* for *Gerrhosaurus*, which was formerly associated with the Zonuridæ, but which agrees closely with the Scincidæ, from which it is to be distinguished by the coalesced premaxillaries. Although the arrangement of the scales of the body is different from what we see in the latter family, the underlying dermal bony plates are precisely similar in their symmetrical canals.

The *Scincidæ* correspond to Cope's Scincidæ, Sepidæ, and Acontiidæ, and to Bocourt's group Aspidoscinciens, less the Diploglossidæ.

The *Anelytropidæ*, a small family so named by Cope and synonymous with the Typhlinidæ of other authors, are a degraded type of the Scincidæ, having completely lost the cranial arches—which, in some forms of the latter group, show a tendency to disappear—and also the osteodermal plates.

The *Dibamidæ*, characterized for the first time, and comprising only the genus *Dibamus*, go still further in the direction of degradation, and are exactly analogous in this series to the Aniellidæ in the other series.

XVII.—*Description of a new Species of* Pseudacræa *from Natal.* By Arthur G. Butler, F.L.S., F.Z.S., &c.

The genus *Pseudacræa* is one of the most interesting groups of butterflies, the species of which mimic the various forms of *Acræa*, *Planema*, &c.

The present species is in the collection of Mr. Walter de Rothschild, and was captured in Natal by Mr. Peter Colville, after whom I have much pleasure in naming it.

The nearest allies of *P. Colvillei* are *P. Trimenii* and *P. Boisduvalii*, between which it is in some respects intermediate; it appears to me to resemble *Acræa horta* rather than the groups copied by its two allies.

Pseudacræa Colvillei, sp. n.

♂. Alæ anticæ area interno-basali rufa, nigro maculata; area apicali cinerea, subhyalina, venis strigisque internervularibus nigris; limbo externo nigrescente; alæ posticæ rufæ, area basali nigro maculata; limbo externo nigro, rufo maculato; corpus nigrum, fulvo alboque maculatum.

Primaries with the basi-internal half reddish fulvous (probably carmine-red when fresh), with black markings, exactly as in *P. Trimenii*; apical half smoky semitransparent grey, with black veins and internervular streaks nearly as in *P. Boisduvalii*, but without the transverse <-shaped markings near the base of the median branches: secondaries nearly as in *P. Trimenii*, but with large oval red spots on the black border, as in the female of *P. Boisduvalii*; form and expanse of wings corresponding with those of the latter species.

Natal (*P. Colville*). Coll. W. de Rothschild.

Although *P. Trimenii* is subject to slight variation in colouring, the secondaries sometimes exhibiting a snow-white patch from the three round black spots crossing the median vein, as in *Acræa acara*, there can be little doubt that the present species is far too distinct from it for a mere sport; its resemblance to an entirely different form of *Acræa*, its different outline, and other characters show it to be clearly a separate species. Neither is it any more remarkable that two *Pseudacræas* of the same group should occur in Natal than that the corresponding forms of *Acræa* should independently exist there; the only strange thing is, in spite of the rarity of the species in this genus, that the present species has not already been described.

The allied *P. Boisduvalii* inhabits Western and Southwestern Africa.

XVIII.—*Moas and Moa-hunters.* By A. de Quatrefages *.

When I published, in the 'Journal des Savants,' a first article upon New Zealand and its inhabitants† we had received in Europe only the first three volumes of the 'Transactions' in which are brought together the works of the learned societies of New Zealand. At that time I had to express my regret that this collection contained only a single very short note relating to the large short-winged birds designated by the common name of *Moas* ‡. This deficiency has since been filled up. The succeeding volumes have brought us numerous memoirs, in which the various questions raised by the history of these birds are treated of. My present object is to give a general summary of these researches, which are very interesting in many respects, avoiding too technical details, for which I can only refer the reader to the writings of MM. Haast, Hochstetter, &c., and especially to those of Sir Richard Owen, which have been classical since their appearance.

I.

We must first of all refer to the most striking feature of the New-Zealand fauna.

The travellers who first landed upon this distant country § were surprised at finding there of Mammalia only a domestic dog and a rat, which the natives hunted as game. Since then two bats of different genera have been discovered ||. The researches of geologists have extended to palæontological times the results furnished by the study of the living animals, and have even rendered them still more strongly marked. No fossil mammal has yet been discovered through the whole

* Translated by W. S. Dallas, F.L.S., from the 'Annales des Sciences Naturelles,' sér. 6, tome xvi.

† In January 1873. The present memoir has also appeared in the same journal (in the numbers for June and July 1883).

‡ "Address on the Moa," by the Hon. W. B. Mantell (Trans. and Proc. of the New Zealand Institute, vol. i. p. 18). Mr. Mantell alone has occupied himself with the general history of the Moas. But it is only just to add that in the same volume Dr. Haast gave a memoir, entirely technical in its nature, in which he published the results of measurements made upon very numerous bones (*ibid.* p. 80).

§ New Zealand was discovered by Tasman on the 13th December, 1642. It was forgotten and in a manner lost for more than a century, and was rediscovered by Cook on the 6th October, 1769.

|| *Scotophilus tuberculatus* (Gray), identical with an Australian species, and *Mystacina tuberculata*, which has hitherto been found only in New Zealand. (Note communicated by M. Alphonse Edwards.)

extent of the lands composing New Zealand. This rendered the exceptions which I have just indicated even still more striking. How are we to interpret the existence of these four isolated species, each representing one of the subtypes of the class, and not preceded by any other belonging to the fundamental group? We have here a strange fact with no analogy elsewhere. Nowhere else do we see a whole class of animals entirely wanting in the fossil faunas and only represented in the existing fauna by an insignificant number of species belonging to distinct orders. On the contrary, there always exist more or less close affinities between the past and the present in the animal creation. We know that these relations are even every day invoked as so many arguments in favour of the transformist doctrines.

The New-Zealand fauna therefore presents a unique exception to one of the most general facts hitherto ascertained. Now it is very difficult to admit the existence of exceptions of this kind. One is therefore naturally led to inquire whether some accidental phenomenon has not intervened here to mask the natural facts—whether this dog, this rat, and these bats really belong to the New-Zealand fauna, whether they are not simply colonists introduced, it matters not how, into a country to which they were originally strangers.

The presence of the Chiroptera might easily be ascribed to a fact of accidental dissemination resulting from a few blasts of wind, as has been demonstrated at the present day in the same regions *. But that of the two terrestrial mammals has long remained unexplained.

To solve this curious problem of zoological geography Sir George Grey has had to discover, translate, and publish the historical songs which have furnished equally precise and curious information upon the first origin of the Maoris. Through him we have learned that on quitting Hawaïki for the new country discovered by Ngahué the emigrant chiefs brought with them the plants and animals of which experience had taught them the utility. The dog and the rat figure in the list of these treasures of the colonist †, and still attest

* *Zosterops lateralis* (Latham), a bird originally inhabiting Australia, has been carried in this way to New Zealand and into Campbell Island. It did not exist in the Chatham Islands until 1861. At this time it appeared suddenly after a storm ("Rapport sur l'exposition faite au Muséum des objets d'histoire naturelle recueillis par MM. de L'Isle et Filhol," par A. de Quatrefages, 'Archives des missions scientifiques et littéraires,' tome v. p. 24).

† 'Polynesian Mythology,' 1855; 'The Emigration of Turi,' pp. 212, 214; 'The Emigration of Manaïa,' p. 228. I have analyzed these documents and all those relating to the same set of ideas in a work entitled

the exactitude of the traditions for the knowledge of which we are indebted to the late Governor of New Zealand. They did not originate in those islands, but they were imported there *.

The Mammalia which did not occur in the natural fauna of this archipelago were to a certain extent replaced by birds belonging to a peculiar type, represented elsewhere by a very small number of species, but which here acquired an absolutely exceptional development. I refer to birds with rudimentary wings and with loose-barbed feathers, incapable

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'Les Polynésiens et leurs migrations,' accompanied by four maps. I only remind the reader that *Hawaïki* here mentioned is one of the Manaia Islands, and probably Armstrong Island or Bourouti of our atlases.

* New Zealand now possesses mammals which the Europeans have introduced there, and the acclimatization of which has not been without its inconveniences. Our common rat has almost entirely destroyed the rat imported by the colonists from Hawaïki, the Kiore of the Maoris. As a matter of course the mouse has accompanied it. Our cat has returned to the wild state in this island, and it is probably one of these animals that has been taken for an indigenous species of otter supposed to have been once seen. Our rabbit has multiplied there, as in Australia, to such an extent as to become a plague in the cultivated lands; so much so indeed that a few years ago the Acclimatization Society of Paris received an application for a certain number of weasels, for which 100 francs a pair were offered. They were to have been set free, in the hope that they would multiply and wage war against the rabbits. But it is easy to understand that the remedy might have been worse than the disease. As to the pigs, introduced by Cook in 1769, they are now so numerous and commit such ravages that hunters are expressly engaged to destroy them. Hochstetter tells us that in twenty months three men, hunting over an extent of 250,000 acres, killed no fewer than 25,000 wild pigs, and undertook to kill 15,000 more upon the same ground ('New Zealand,' p. 162). These wild pigs will speedily bring about the complete extinction of the last wingless birds of the country (*Apteryx*), of which they destroy the nests.

In other respects the acclimatization of foreign animals has proceeded in New Zealand with astonishing rapidity. Fourteen species of birds, coming from Europe, Asia, and America, have made themselves a new home in this maritime country. The colonists have transported there not only the sparrows and larks, but also the pheasant and the Californian quail. All these new comers have driven before them the indigenous species, the representatives of which are becoming scarcer and scarcer, while several of them appear to be menaced with a speedy extinction.

We may notice in passing that the invasion of New Zealand by foreign plants has been no less general and no less fatal to the indigenous vegetation. Our cereals and our vegetables everywhere replace the batatas and cause the eradication of the ferns on the roots of which the Maoris fed. Even our *weeds*, transported here involuntarily, have multiplied to such an extent as to extinguish those of the country. "In the plain of Christchurch," writes M. Filhol, "it is in vain to seek—we can no longer find—a Polynesian plant; one might fancy oneself in Beauce" ("Rapport sur l'exposition," &c., *loc. cit.*).

of flight and more or less analogous to the ostrich or the cassowary *. Four or five species of this group still exist in New Zealand. They are known to the natives by the common name of *Kiwi*, and have been placed together by naturalists in the genus *Apteryx* †. They vary in size from that of a fowl to that of a turkey. But the number of extinct species is far more considerable, and among them are some of truly gigantic proportions. It is these vanished species that are called by the common name of *Moa*, borrowed from the language of the Maoris ‡.

The first investigations upon this curious chapter of ornithology date from 1830. The illustrious English anatomist, Richard Owen, had received from a Mr. Rule the middle portion of a femur, and from the examination of this single imperfect specimen he drew conclusions which every thing has tended to confirm §. More abundant and more complete

* Beyond New Zealand the ornithological type in question is only represented by four species, each having a very different area of habitat and isolated from the others by vast spaces. These are the ostrich (*Struthio camelus*, Linné), which inhabits almost the whole of Africa and the warm parts of Asia on this side of the Ganges; the nandou, or American ostrich (*Rhea americana*, Lath.), which inhabits South Americe from Brazil to Patagonia; the emeu, or helmeted cassowary (*Casuarius emeu*, Lath., *Struthio casuarius*, Linné), found only in the Indian Archipelago and principally in the forests of Ceram; and lastly the emou, or helmetless cassowary (*Casuarius novæ-hollandiæ*, Lath.), which appears to have been spread over the whole of Australia, but which the European colonists drive back more and more and will not fail to destroy. [It will be remarked here that M. de Quatrefages refers only to four *species* instead of four *genera*. The number of species is considerably greater, there being three known species of *Rhea*, two species of *Dromæus*, and nine of *Casuarius*. The last-named genus has a much wider range than is indicated above, extending from the Indian Archipelago to the island of New Britain and to Northern Australia.—Tr.]

† These species are *Apteryx australis*, *A. Mantelli*, *A. Owenii*, and *A. Haastii*. A fifth species of large size perhaps exists in the desert regions of the Middle Island. It has even been described by Verreau, a French natural-history traveller. But he had never seen more than a single skin covered with feathers, of which a Maori chief had made himself a mantle. (Note communicated by M. Alphonse Edwards.)

‡ The Kiwis were in existence at the same time as certain species of Moas. Their bones have been found mixed together in caves and also among the *kitchen refuse*, of which I shall speak hereafter. The Moas, moreover, are not the only birds the species of which have disappeared from New Zealand. Owen has shown that this is also the case with two Rallidæ, of which he makes the genus *Aptornis*. Dr. Haast has described the remains of a large bird of prey, which he has named *Harpagornis Moorei*; it is perhaps the *Weka* spoken of in certain Maori traditions (see "Notes on *Harpagornis Moorei*," by J. Haast, in Trans. &c., vol. iv. p. 192, pls. x. and xi.).

§ Sir Richard Owen made his first communication on this subject to the Zoological Society of London on the 13th November, 1839. He fol-materials soon enabled him to recognize five distinct species, which he united into the genus *Dinornis*.

Subsequently this number gradually increased to thirteen, and there have been found in these representatives of an extinct fauna more and more marked differential characters. This is so much the case that Dr. Julius Haast, the eminent New-Zealand geologist, has thought it right to form of them four genera, themselves divided into two groups or families *.

It is easy to see that these palæontological discoveries confirm the observations which I have just been making and bring New Zealand under the general rule. This austral country has never produced Mammalia. To make up for this the type of the short-winged birds has been developed there with an abundance and a variety of secondary types such as we meet with nowhere else. There is complete accordance between its fossil and its recent faunas, and these faunas, precisely by the exceptional character which is common to them, furnish another proof of the universality of the laws which everywhere bind together the past and the present of the animal world †.

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lowed out his researches chiefly by the aid of the materials sent by Mr. W. Mantell. The results have appeared in the 'Transactions of the Zoological Society' for 1844 and following years.

* The following is Dr. Haast's classification, which, however, only includes eleven species:—I. Family Dinornithidæ: genus *Dinornis*, including *D. maximus, D. robustus, D. ingens, D. struthioides, D. gracilis*; genus *Meionornis*, including *M. casuarinus, M. didiformis*. II. Family Palapterygidæ: genus *Palapteryx*, including *P. elephantopus, P. crassus*; genus *Euryapteryx*, including *E. gravis, E. rheides* (Proc. Philos. Inst. of Canterbury, March 1874; Address by J. Haast, president; Transactions, &c., vol. vi. p. 426). Dr. Haast, from considerations drawn especially from size, seems disposed to think that he has himself united under the name of *Meionornis casuarinus* two species which will have to be distinguished hereafter. He makes analogous remarks with regard to *Palapteryx elephantopus* (p. 429). Prof. Hutton, Director of the Museum at Otago, has criticized Haast's classification, and denied some of the facts relied upon by his *confrère*. With Owen, he thinks that the Moas form only a single natural family, that of the Dinornithidæ ('Transactions &c., vol. ix. p. 363). Owen and M. A. Edwards only admit the two genera *Dinornis* and *Palapteryx*, the former tridactyle, the latter having a fourth digit, which is short and directed backward.

† The preceding observations apply not only to the history of the New-Zealand fauna, but affect the history of man himself. By themselves they suffice to refute a theory recently put forward by M. P. A. Lesson in a book in other respects filled with important facts and documents, of which three volumes out of four have appeared, namely 'Les Polynésiens, leur origine, leurs migrations et leur langage' (Paris, 1882). The author assumes that the whole of Polynesia, Tahiti, the Sandwich Islands, the Samoa and Tonga Islands, &c. has been peopled by means of migrations;

The number of Moa-bones gathered by the scientific men or by simple amateurs inhabiting New Zealand is very considerable, and it is only just to acknowledge the generosity with which these scientific treasures have been communicated to those whom they might interest, and even divided among the naturalists of the whole world. All the great museums of Europe and America now possess more or less complete specimens of these strange birds. Mr. Mantell, who was one of the first to interest himself in the question, has sent to Sir Richard Owen more than 1000 specimens *.

When the learned geologist of the 'Novara,' M. Hochstetter, wished to dig for himself in the marshes and bone-caves, he found everywhere the most earnest cooperation. It has been the same with our countryman, M. Filhol †.

It is to the kindness and liberality of our New-Zealand *confrères*, and especially of MM. Haast and Hutton, that we

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but instead of accepting the Malay Archipelago as the starting-point of the race, he makes *Polynesian man* originate in New Zealand. He thus reverts to the old doctrine of autochthonism, of which the magnificent work of Mr. Hale had already demonstrated the untrustworthiness, and at the same time he places the cradle of the Polynesian islanders upon the land which affords least support to any hypothesis of this kind. I have already briefly examined M. Lesson's theory, and indicated how, independently of the data furnished by the study of the faunas, the historical documents which we owe in part to that author himself, but principally to Sir George Grey, Thomson, Shortland, &c., do not allow of our accepting it ('Hommes fossiles et hommes sauvages,' p. 483). I shall return to this subject when M. Lesson's work is completed.

* Hochstetter, *loc. cit.* p. 182.

† MM. Filhol and de L'Isle were attached as naturalists in 1874 to the expeditions sent out to observe the transit of Venus at St. Paul and Campbell Islands, under the command of Admiral Mouchez and M. Bouquet de Lagrye. Both of them brought back important collections. But M. de l'Isle, being prevented by illness, could not realize all that was promised by his known zeal. More fortunate, M. Filhol fulfilled his mission in a remarkable manner. After having thoroughly explored Campbell Island, he went twice to New Zealand, of which he traversed the principal provinces. He afterwards visited the Fiji Islands, New Caledonia, and the Sandwich Islands, and returned to France by San Francisco. From wherever he went he brought back remarkable collections and most interesting observations. Prof. Hutton, Director of the Museum of Otago, gave M. Filhol for our museum numerous bones of Moas and two complete skeletons, one of *Palapteryx elephantopus*, the other of *P. crassus* ("Rapport," &c., *loc. cit.*).

On his part Dr. Haast has sent us, besides a great number of separate bones, four nearly complete skeletons, which could be mounted, namely of *Dinornis crassus*, *giganteus*, *elephantopus*, and *didiformis*.

The museum also possesses a model in plaster of the magnificent *Dinornis ingens*, collected and reconstructed by Hochstetter and figured in his book, pp. 187 and 188.

are indebted for the magnificent specimens which now figure in the museum. I shall not be reproached for having dwelt upon these facts, and here publicly thanking men who so worthily understand and practise scientific confraternity.

II.

This abundance of materials has enabled us to form a pretty complete idea of what the Moas were. We have been able to reconstruct entire skeletons of several species, and thus to judge of their size and their proportions. On the whole, and notwithstanding the secondary differences which distinguish them, all these birds, as I have already said, resemble the ostrich or the cassowary. The head is small, and nothing in it indicates the existence of a solid crest analogous to that which distinguishes the emeu [*Casuarius*], and has obtained it the name of the helmeted cassowary. The very long neck, at first slender, gradually thickens as it approaches the trunk, as in the cassowary. The skeleton of the body is robust. The sternum alone is comparatively very small and flat. The reduction of this bone, so highly developed in flying birds, is explained here by the smallness of the wings, which are truly rudimentary. On the other hand, all that portion of the skeleton connected with the hinder limbs has acquired exceptional dimensions. The pelvis is massive; the bones of the thigh, the leg, and the metatarsus have enormous heads, and the body of the bone itself is comparatively much thicker than in the living representatives of the type. These characters are particularly marked in *Palapteryx elephantopus*. This bird was a little smaller than our ostriches, and nevertheless in it the metatarsus presents a circumference nearly double that of the same bone in the ostrich and the Cassowary *.

The size varied in a very noticeable manner in the different species of Moas. The smallest (*Meionornis didiformis*) was only 3 or 4 feet (0·97–1·30 m.) in height †. These were therefore very inferior to the ostrich, the size of which varies from 6 to 7 feet (1·95–2·27 m.). But *Palapteryx ingens* was precisely of this same size; *Dinornis robustus* was 8 to 9

* Hochstetter, *loc. cit.* p. 138.

† I borrow all these numbers from Hochstetter's table of measurements (*loc. cit.* p. 198). That learned traveller seems to have judged of the size not by measuring the distance from the beak to the extremity of the feet, but by supposing the bird in repose in its position of equilibrium, the neck inclined forward and presenting a double curvature, just as he has represented *Palapteryx ingens*, the entire skeleton of which is at Vienna (*loc. cit.* p. 188).

feet (2·60–2·92 m.) high, and *Dinornis maximus* raised its head to 9 or 10 feet (2·92–3·25 m.) from the surface of the ground. Thus it exceeded by nearly a metre our largest ostriches. According to Thomson, cited by M. Alphonse Edwards in an unpublished work which he has been kind enough to communicate to me, there even existed individuals 13 to 14 English feet (4·0–4·25 m.) in height.

By comparing a great number of bones of adult individuals of the same species, Dr. Haast has ascertained that they always formed two series of slightly different size. He has attributed this inequality to sex, and, guided by what occurs in the *Apteryx*, he regards the larger bones as having belonged to females *.

Besides the osseous remains of Moas, there have been discovered fragments of eggs and even some entire eggs, most of which, unfortunately, have been broken. But it has been possible to restore a considerable number †. These eggs, of a pale yellow colour‡, are dotted over with hollow points and little grooves §. Their volume was considerably greater than that of the eggs of the ostrich, but without equalling in this respect those of *Æpyornis* ‖. In one of them the bones of

* Address ('Transactions' &c. vol. vi. p. 428).

† Mr. Mantell alone has reconstructed a dozen of these eggs, which he has for the most part divided between the British Museum and the Museum of the Royal College of Surgeons. Among these specimens, which testify so strongly to the address and patience of the author, there are some which contain no less than 200 or 300 pieces brought together ("On Moa-beds," 'Transactions' &c. vol. v. p. 94).

‡ [The fragments of egg-shell which accompanied the York specimen were of a dark green colour; the pale yellow specimens must have been bleached.—Tr.]

§ "On the Microscopical Structure of the Egg-shell of the Moa," by Capt. F. W. Hutton ('Transactions' &c. vol. iv. p. 166, pl. ix. figs. 1–5). The shell of the egg, about 1·75 millim. (0·07 inch) in thickness, consists of two layers. The outer one is formed by lamellæ parallel to the surface, the inner one by a kind of prisms perpendicular to the former. Other observers speak of these eggs as being perfectly smooth. It may be, perhaps, that the little grooves in question here are due to the action of grains of sand driven by the wind. We know, in fact, that this action is exerted even upon rocks much more resistant than egg-shells, and this fact has been demonstrated precisely in New Zealand.

‖ *Æpyornis maximus* inhabited Madagascar. It was destroyed by the hand of man, but we do not know at what period. The eggs and some bones were described for the first time by Isidore Geoffroy Saint-Hilaire ('Comptes Rendus,' 1851, tome xxxii. p. 101, and Ann. des Sci. Nat. sér. 3, tome xiv. pp. 206 and 213). M. Alphonse Edwards, having received fresh materials, has produced a very complete memoir upon this species ('Recherches sur la faune ornithologique des iles Mascareignes et de Madagascar,' p. 85, 1873). From the investigations of this naturalist it appears that *Æpyornis* approached the Moas, although presenting characters proper to make it the type of a family probably including three a young fœtus were found, and Dr. Hector has been able to compare them with those of an embryo of the emou [*Dromæus*] of the same age *. It is interesting to find that, even at this period of life, the principal differential characters are distinctly marked, and that the pelvis, the bones of the leg, &c. are much more voluminous in the Moa than in its near relative from New Holland.

Lastly, isolated feathers of Moas belonging to various parts of the body have been collected from time to time at different places, as also even portions of the skeleton, to which muscles, tendons, shreds of skin, and feathers still adhered in a remarkable state of preservation†. I shall revert hereafter to the consequences to be drawn from these facts. I only speak of them here to complete the description of these birds.

Prof. Hutton has investigated the feathers found in two localities in the midst of bones of Moas. These feathers belonged to the same species. They were as fresh and their colours were as bright as if they had just been pulled out. But all were broken except a single one, of which he gives a figure ‡. The total length is 16 centim. (6 inches). The tube is only 5 or 6 millim. ($\frac{1}{4}$ inch) long, and bears two very slender

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species. In particular the bones of the metatarsus were still stouter and more massive than even in *P. elephantopus*. Its height must have been about 2 metres. Its eggs, several of which are in existence, have a capacity of more than 8 litres, and represent in volume six ostrich eggs and 148 hen's eggs.

* "On recent Moa-remains in New Zealand," by James Hector ('Transactions' &c. vol. iv. pl. vi. figs. 3, 4). The same plate gives drawings of the eggs of the moa and of the emou (*Dromæus*), reduced to one third the natural size (figs. 1, 2).—Letter from Mr. T. M. Cockburn Hood to Dr. Hector ('Transactions' &c. vol. vi. p. 387).

† "Address on the Moa," Extracts, by the Hon. W. B. Mantell (Transactions &c. vol. i. p. 19); "On some Moa-feathers," by Capt. F. W. Hutton (*ibid.* vol. iv. p. 172); "On recent Moa-remains in New Zealand," by James Hector, M.D., F.R.S. (*ibid.* vol. iv. p. 110). Analogous facts are often referred to in other memoirs, and I shall have to return to them.

[It is curious that throughout the articles published in New Zealand on the Moa, there is scarcely any mention of the finest and most interesting Moa-skeleton in existence, namely that of *Dinornis robustus* in the museum at York, and M. de Quatrefages also says nothing about it. And yet this specimen not only is a nearly perfect skeleton of an individual bird, but its bones were in part united by ligaments and covered with skin, which bore the bases of feathers: parts of the skin of the foot were preserved, and much dried muscle was attached to some of the bones. With the skeleton were some bones of young chicks and a few fragments of green eggs.—See Thomas Allis, in Journ. Linn. Soc. vol. viii. pp. 50 & 140; R. Owen, "On *Dinornis*, nos. ix. & xi.," Trans. Zool. Soc. vols. v. & vi.; and W. S. Dallas, Proc. Zool. Soc. 1865.—Tr.]

‡ *Loc. cit.* pl. ix.

stems, the barbs of which, although furnished with barbules, remain separate from each other. These barbs, which are at first very short, attain a length of about $2\frac{1}{2}$ centim. (1 inch), and the feather terminates with a rounded margin. The first two thirds from the base are of a more or less reddish brown, which gradually passes into black, while the rounded extremity is of the purest white. Prof. Hutton points out that these characters approximate the Moas to the American and Australian brevipennate birds rather than to the African ostrich*.

As a matter of course, however, all the Moas had not the same plumage. The discoveries of Mr. Taylor White in this respect furnish a confirmation of what was easy to foresee. In the cave of Mount Nicholas he found feathers of a pale yellowish-brown colour, darker at the margins. Some were of a blackish brown. The feathers from another cave, near Queenstown, were of a reddish brown and marked with a dark brown streak towards the extremity of the stem †. Thus we know, at least partially, the plumage of three species of Moas‡.

The feathers which I have just described came no doubt from the middle or posterior region of the body. The precious specimen described and figured by Dr. Hector shows the modifications presented in this respect by the anterior dorsal region and the neck §. This includes seven vertebræ, the first dorsal, and the six lowest cervicals, united by their ligaments, and retaining upon one side their muscles and integuments. The author believes that the neck of this Moa was 18 English inches in circumference at its base.

Upon the portion of this specimen corresponding to the first dorsal vertebra, the skin is seen to be covered with large conical papillæ which nearly touch each other, and give the whole the appearance of a rasp. A certain number of these papillæ bear double-stemmed feathers of a reddish-chestnut colour, furnished with barbs like those of the preceding feathers, but the longest of which are at the utmost 2 inches long. The papillæ diminish in size and the feathers in length on arriving at the level of the cervical vertebræ. Soon the feathers appear to be reduced to mere hairs, and they disappear entirely upon about half the specimen. There the papillæ are much smaller and are distinctly separated from each other.

* *Loc. cit.* p. 173.

† *Loc. cit.* p. 114, pl. v., with five figures.

‡ "Notes on Moa-caves in the Wakatipu District," by Taylor White ('Transactions' &c. vol. viii. p. 97).

§ Note added to the preceding by F. W. Hutton (*ibid.* p. 101).

Taking into account these various data and the characters distinguishing the Brevipennes inhabiting the other regions of the globe, we may form a very precise idea of what these large species of Moas were like. They presented the general form of the emeu [=Cassowary], but upon a much larger scale. Like this, they had the greater part of the neck naked; but they were destitute of the characteristic crest, and in this respect resembled the emou [*Dromæus*]. Very probably the legs were naked and the body was covered with silky plumes, in which darker or lighter and more or less reddish tints of brown predominated, variegated with black and white, at least in some species.

Documents, to which I shall have to return further on, enable us to complete this picture, and make known to us the mode of life of these strange birds*. The Moas were sluggish and stupid animals, as is shown by a proverb which is repeated at the present day†. They were essentially sedentary and went about in pairs accompanied by their young. No doubt they sometimes disputed the field on which they were seeking the same food, for the Maoris still, in speaking of a struggle between two pairs of combatants, say—"Two against two, like the Moas." Their nests were formed of various dried grasses and fragments of ferns simply brought together into a heap. They ate various species of plants growing upon the borders of the woods and marshes, the young shoots of certain shrubs, &c.; but their principal food appears to have been the root of a species of fern which they dug up either with the beak or with the feet. To assist in the trituration of these articles of food, the Moas, like many other birds, swallowed small pebbles, which, when rounded and polished by friction in the stomach, acquire a peculiar aspect and are still called Moa-stones by the natives, who know them well‡. But this very polish rendered them unfit for the service which the bird expected from them, and then he disgorged them just as do the ostrich and the emou§

* Letter from Mr. John White to Mr. Travers ('Transactions' &c. vol. viii. p. 81). Mr. Travers informs us that his correspondent has occupied himself for more than thirty-five years in collecting all possible information upon the past of the Maoris, that he has been initiated by their priests into all the mysteries of indigenous knowledge, so that he knows the history of their race better than the natives themselves.

† Extracts from a letter from F. L. Maning, Esq., relative to the extinction of the Moas ('Transactions,' &c. vol. viii. p. 102). The author translates the Maori proverb by the words, "as inert (ngoikae) as a Moa."

‡ 'Hochstetter,' p. 186.

§ "Note on Discovery of Moas and Moa-hunters' Remains at Patana River, near Wangarey," by J. Thorn. jun. ('Transactions,' &c. vol. viii.

[*Dromæus*]. These stones were not always of the same nature, and varied with the localities*.

III.

The details that I have just given assume not only that man and the Moas were contemporaneous, but also that the disappearance of the latter is of recent date. Such, in fact, is the conclusion to which we are led by the results of a regular inquiry pursued in New Zealand for nearly forty years by a great number of investigators and distinguished naturalists. Nevertheless, until the last few years it was quite permissible to harbour doubts on the subject. One of the most authoritative of New-Zealand geologists, Dr. Julius Haast, has pronounced most absolutely in a very different sense. While accepting as demonstrated the coexistence of man and the Moas at a very distant epoch answering to our prehistoric times, he denies that the Maoris themselves ever knew these great birds†.

On the other hand, Mr. W. Mantell, to whom his numerous researches justly give an authority upon this point, has distinctly and repeatedly expressed the opposite opinion, and believes that these large Brevipennes were hunted and exterminated at a comparatively recent epoch by these very Maoris‡.

Lastly, Mr. Stack, who is accepted by his *confrères* as a very competent judge, has adopted an intermediate opinion. He regards the belief in the recent destruction of the Moas as inadmissible, but does not wish to throw it back into a very distant past§.

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p. 85). A certain number of these Moa-stones have been collected and appear in the museum at Auckland, and no doubt in other collections in New Zealand.

* Haast, *loc. cit.* p. 73.

† "Moas and Moa-hunters: Address to the Philosophical Institute of Canterbury, 1871," by Julius Haast ('Transactions,' &c. vol. viii. p. 66, 1872). Dr. Haast has maintained his original opinion in other memoirs, and in the work that he has published under the title of 'Geology of the Provinces of Canterbury and Westland, New Zealand,' 1879.

‡ "On the fossil Remains of Birds collected in various Parts of New Zealand by Mr. Walter Mantell of Wellington," by Gideon Algernon Mantell, LL.D., F.R.S. (Quart. Journ. Geol. Soc. vol. iv. p. 225, 1848); "Address on the Moas:" Extracts by W. B. Mantell ('Transactions' &c. vol. i. p. 18, 1869). However, in this latter paper Mr. Mantell seems disposed to throw further back the epoch of the destruction of the Moas, in consequence of the obscurities in the traditions which he has been able to collect upon the subject. Mr. White's letter already cited, and to which I shall revert, fully answers this objection.

§ "Some Observations on the Annual Address of the President," by the Rev. J. W. Stack ('Transactions' &c. vol. iv. p. 107).

To show how the question has become elucidated, and justify the point of view which I have adopted, it is necessary to enter into some details.

The bones of Moas have been met with under the most different conditions of deposition. Sometimes they simply rest upon the suface of the ground, or are scarcely covered by a few centimetres of sand*. But usually they are found buried at various depths in the sands of the seashore, in the alluvia of the rivers, in the marshes, and also in caves. The quantity of these remains accumulated in restricted spaces is sometimes very remarkable.

In digging canals for the drainage of a marsh at Glenmark there were obtained the remains of 144 adult and 27 young birds†. I might cite many other examples, but I confine myself to a summary of the details given by Mr. Booth of the discovery made by him at Hamilton, in a small half-dried lagoon‡.

Having been informed of the discovery of a few bones, he opened a first pit of 4 feet square, and obtained from it fifty-six femora with a proportionate quantity of other bones. Regular diggings were then organized. It was ascertained that the deposit to be worked formed a sort of irregular crescent, measuring 40 feet from one point to the other, and 18 feet across at the middle, with a depth of from 2 to 4 feet. In this restricted space were collected about 3½ tons (more than 8500 kilogrammes) of bones, and those who took part in the work estimated the number of Moas accumulated in this estuary at more than 400.

These bones were very unequally perserved. A great number fell into paste at the least contact. Hence they had not all been deposited at the same period. But in consequence of the conditions of interment the Hamilton swamp could not furnish certain data as to the relative age of the deposits. It is otherwise with the caves, which were scientifically excavated

* Dr. Hector, *loc. cit.* p. 115; Dr. Haast, *loc. cit.* p. 103; Rev. J. W. Stack, *loc. cit.* p. 109; Rev. R. Taylor ('Transactions' &c. vol. v. p. 97). Those bones which were seen in great numbers scattered over the ground have rapidly disappeared. Mr. Stack endeavours to explain their persistence for centuries by saying that the Maoris carefully preserved the jungles, which, on the contrary, the European colonists have caused to disappear. The latter, by destroying this shelter, have facilitated the action of atmospheric agents and have thus brought about the disappearance of these bones, which had hitherto remained intact. I think it useless to point out what, in this interpretation of the facts, has but little foundation and is opposed to daily experience.

† Haast, *loc. cit.* p. 89.

‡ "Description of the Moa-swamp at Hamilton," by B. S. Booth ('Transactions' &c. vol. vii. p. 123, pl. v.).

by Hochstetter. Here very distinct layers, separated by a bed of stalagmite, contained different species. At the top was *Meionornis didiformis*, at the bottom *Palapteryx elephantopus*. The bones of the former seemed to be still fresh, those of the latter were semi-fossilized. This diversity of aspect corresponded with differences of chemical composition, itself connected with more or less advanced alteration. The quantity of organic matter found in the bones of Moas which have been analyzed has proved very variable. It is sometimes only 10 per cent.; but sometimes, also, it rises to 30 per cent. —a proportion almost exactly the same as is met with in fresh bones of the ostrich*.

Hochstetter, arguing from his own personal observations and from some previously known facts, approximated to the opinions of Dr. and Mr. W. B. Mantell. He thought that the extinction of the Moas could not be thrown back several thousand years†. He regarded their existence as alone capable of explaining the development which the population of New Zealand had attained‡, and attributed the origin of anthropophagism to the deficiency of animal food resulting from their extermination§. He consequently identified the existing race of Maoris with the hunters of the Moas.

To sustain a very different doctrine Dr. Haast especially appeals to geology. The bones of Moas, he says, occur principally in the beds which were formed during the glacial period or immediately after it‖. Having himself collected a certain number of these bones *in situ*, it seems to him to be demonstrated that these large birds represented, in New Zealand, the gigantic quadrupeds which inhabited the northern hemisphere during the post-Pliocene period. Hence he does not hesitate to refer the existence of the Moas to an epoch as far from the present time as that of the mammoth, the rhinoceros, cave-lion, and cave-bear, the remains of which are found in European Quaternary deposits; and he asserts that if the Moas survived these times, geologically so different from ours, they were nevertheless speedily annihilated¶.

It will be seen that Dr. Haast seems to assume not only the analogy of the glacial phenomena which took place in New Zealand and in Europe, but also their contemporaneity. We have to do here with geology proper, and questions of this kind are out of my province. Nevertheless, even accepting these two propositions as true, and reasoning by analogy,

* Hochstetter, *loc. cit.* p. 190.
† *Ibid.*
‡ *Loc. cit.* p. 194.
§ *Loc. cit.* p. 196.
‖ *Loc. cit.* p. 68.
¶ *Loc. cit.* p. 75.

we might at once raise some grave objections to the consequences which Dr. Haast draws from them with regard to the antiquity of the extinction of the Moas.

It is very true that the great Mammalia mentioned by Dr. Haast no longer exist and are known to us only by their remains. But with them lived other species which survived them, and are even still living. The monks of St. Gall still ate the urus in the fifteenth century; the reindeer, in Pallas's time, descended in winter to the shores of the Caspian Sea; the aurochs and the elk still inhabit Poland; the chamois, the ibex, and the marmot are close to us. Why should all these species of Moa have been condemned to perish with the geological period that witnessed their appearance?

Dr. Haast no doubt would object to me that the European Mammalia of which I have mentioned the names, and others which it is useless to enumerate, have generally migrated either in longitude or in altitude. But, even without bringing the action of man into play, this change of habitat was imposed upon them by the transformation of the nature of the climate. This had become *continental*, instead of *insular* as it was in glacial times. In New Zealand this was not the case. Whatever may have been the movements of elevation or depression of its land*, it remained isolated in the middle of the sea, and its climate cannot have varied, at least in the lower regions, except within very narrow limits. Dr. Haast himself, although starting from other data than those indicated by me, insists upon considerations of the same kind, and shows very well that, in this great island, the extension of the glaciers by no means involves the existence of a climate much more rigorous than that of the present day †. The general conditions of existence remaining the same, what reason can the New-Zealand palæontologist give for regarding the extinction of all the Moas as necessary?

In all his writings, published to the present day, which have come to my knowledge, Dr. Haast maintains the general opinions indicated above‡. It would seem that they have

* The 'Transactions of the New Zealand Institute' contain several memoirs explanatory of the glacial phenomena of which New Zealand was the theatre. I need not dwell upon these, and I shall only call attention to those of MM. Travers and Dobson, who, in expounding their own views, have summed up those of their *confrères* (see "Notes on Dr. Haast's supposed Pleistocene Glaciation of New Zealand," by W. F. L. Travers, vol. vii. p. 409, and "On the Date of the Glacial Period," by A. Dudley Dobson, *ibid.* p. 440). But, upon this question, Dr. Haast's work upon the geology of the Provinces of Canterbury and Westland should especially be consulted.

† *Loc. cit.* p. 72.

‡ Besides the "Address," above cited, Dr. Haast has published, in the

for him the value of axioms capable of serving as a criterion—so much so that positive or negative facts have no value in his eyes, or rather cannot really have taken place, except they agree with his theory. If we speak to him of more or less complete skeletons found upon the ground side by side with a little heap of Moa-stones, which would seem to indicate that the bird died upon the spot and has never been buried, he declares that he cannot believe that these bones could have resisted the influence of atmospheric agents for hundreds if not thousands of years*. If we speak to him of the recollections preserved by the natives with regard to the existence of the Moas, their external characters, their mode of life, and the means employed in killing them, he replies, that the most civilized Europeans have no traditions relating to the mammoth and the rhinoceros, and that an inferior race which has attained only to a condition corresponding to that of our neolithic populations cannot have preserved any relating to an epoch separated from them by an immense number of years†. He adds that distinguished men have vainly inquired into the traditions in question‡. He refers particularly, like Dr. Colenso, to the fables which, in New Zealand as everywhere else, have become mixed up with the recollection of actual facts in the memory of peoples§. He connects what is said of the Moas with vague reminiscences of Cassowaries brought by the Maoris from their original country ||, or with information furnished by occasional emigrants¶. The examination of the *ovens*, exactly like those of the present islanders, and of the remains of repasts containing bones of Moas, furnishes him with a demonstration of the contemporaneity of certain men with those birds**; but the former, in his eyes, were an absolutely savage population, knowing only how to chip and not to polish stone. If some

'Transactions of the New Zealand Institute,' the following memoirs upon the same subject:—in vol. iv. 1872, "Additional Notes," p. 90; "Third Paper on Moas and Moa-hunters," p. 94, pl. vii.; in vol. vii. 1875, "Researches and Excavations carried on in and near the Moa-bone Point Cave, Sumner Road, in the Year 1872," p. 54; "Notes on an Ancient Native Burial-place near the Moa-bone Point Cave, Sumner," p. 54, pls. iii. & iv.; "Notes on the Moa-hunter Encampment at Shag Point, Otago," p. 91; "Results of Excavations and Researches in and near the Moa-bone Point Cave, Sumner Road (Postscript)," p. 528.

Dr. Haast has also maintained his theory and the consequences which he derives from it in his book entitled, 'Geology of the Provinces of Canterbury and Westland, New Zealand,' 1879.

* "Address," p. 71.

† *Ibid.* p. 75.

‡ *Ibid.* p. 76 *et seqq.*

§ *Ibid.* p. 76.

|| *Ibid.* p. 77.

¶ *Ibid.* p. 106.

** *Ibid.* p. 82.

polished *haches* have been found mingled with the ancient kitchen-middens, this, he declares, is because they were lost or intentionally hidden in modern times, long after the hunters of the Moas had disappeared*. The latter, he says repeatedly, never had any thing in common with the Maoris who occupied New Zealand at the time of the arrival of the Europeans.

I think I have sufficiently indicated the mode of reasoning and the nature of the arguments employed by Dr. Haast. I shall not follow him here into the discussion of a number of subjects upon which he touches, but which are only indirectly connected with the principal question. However, I think I ought to quote literally the conclusions with which he terminates his third memoir †:—

"1. The different species of the *Dinornis* or Moas began to appear and flourish in the post-Pliocene period of New Zealand.

"2. They have been extinct for such a long time that no reliable tradition as to their existence has been handed down to us.

"3. A race of *Autochthones*, probably of Polynesian origin‡, was contemporary with the Moa, by whom the large wingless birds were hunted and exterminated.

"4. A species of wild dog was contemporaneous with them, which was killed and eaten by the Moa-hunters.

"5. They did not possess a domesticated dog.

"6. This branch of the Polynesian race possessed a very low standard of civilization, using only rudely chipped stone implements, whilst the Maoris, their direct descendants§, had, when the first Europeans arrived in New Zealand, already a high state of civilization in manufacturing fine polished stone implements and weapons.

"7. The Moa-hunters, who cooked their food in the same manner as the Maoris of the present day do, were not cannibals.

"8. The Moa-hunters had means to reach the Northern Island, whence they procured obsidian ||.

* *Ibid.* pp. 85, 104.

† Third paper, 'Transactions' &c. vol. iv. p. 106.

‡ It is difficult to understand the association of ideas which Dr. Haast here wishes to express.

§ Here, again, Dr. Haast's idea is not easy to understand. Throughout he carefully distinguishes the existing Maoris from the Moa-hunters. Here he seems to regard the former as being the grandsons of the latter.

|| Dr. Haast's investigations were made principally in the province of Canterbury, which is in the South Island.

"9. They also travelled far into the interior of this island to obtain flint for the manufacture of their primitive stone implements.

"10. They did not possess implements of nephrite (greenstone)*.

"11. The polishing process of stone implements is of considerable age in New Zealand, as more finished tools have been found in such positions that their great antiquity cannot be doubted, and which is an additional proof of the long extinction of the Moas."

Thus Dr. Haast here appears to be absolute in every thing, and it is with an appearance of absolute certainty that he asserts or denies facts. But we shall see that he has himself been obliged to go back over some of these propositions and to recognize that some of them are not well founded. Nevertheless the general convictions of the learned geologist have not been shaken on this account, and we shall have to inquire whether this persistence is justified.

[To be continued.]

XIX.—*On the Presence of Eyes and other Sense-Organs in the Shells of the* Chitonidæ. By H. N. Moseley, M.A., F.R.S., Linacre Professor of Human and Comparative Anatomy in the University of Oxford.

On examining a specimen of *Schizochiton incisus*, preserved in spirit amongst a number of other animals dredged by Captain W. Chimmo, R.N., in the Sulu Sea, in H.M.S. 'Nassau' in 1871, and by him presented to the Anatomical Department of the Oxford University Museum, I was astonished to remark on the shells certain minute, highly refracting, rounded bodies arranged in rows symmetrically; they struck me at once as resembling eyes, and further examination proved that such is really their nature. On searching for eyes on the shells of other Chitonidæ I found them present in the majority of the genera, differing, however, in each genus more or less in structure and arrangement.

The eyes in the Chitonidæ are entirely restricted to the outer surface of the shells on their exposed areas (tegmentum), not extending at all on to the laminæ of insertion (articula-

* It is with this stone, often called *jade*, that the Maoris fabricated their stone clubs, *haches*, and various ornaments. It was of great value in their eyes, and often plays a part in their legends. Upon this point I have given some details, borrowed from Sir George Grey, in a book entitled 'Les Polynésiens et leurs migrations.'

mentum), and never being present on the girdle or zona, which is occupied, as is well known, by various calcareous structures, some of which have been carefully investigated by Reincke *.

In the case of all the intermediate shells the eyes are confined to the areæ laterales, or to the line of demarcation between the areæ laterales and the area ventralis, which latter is usually entirely devoid of them.

The eyes, which are mostly circular in outline as seen on the shell-surfaces, measure about $\frac{1}{175}$ of an inch in diameter in *Schizochiton incisus*, $\frac{1}{350}$ of an inch in *Acanthopleura spinigera*, and in *Corephium aculeatum* (in which they are oval in outline) $\frac{1}{600}$ of an inch by about $\frac{1}{400}$. In *Enoplochiton* they are smaller still and only with difficulty seen at all.

The eyes appear, when viewed by reflected light with a low power of the microscope, as highly refracting, convex, circular spots, looking as if made of glass or crystal; they are surrounded and set off by a narrow zone of dark pigment, which is the margin of the choroid seen through the superficial shell-substance. In the centre of each convex spot is a smaller circular area, somewhat darker, caused by the outline of the iris, but showing a brilliant speck of totally reflected light, due to the lens.

The entire substance of the tegmentum in the Chitonidæ is traversed by a series of branching canals, which are occupied in the living condition of the animal by corresponding ramifications of soft tissues, accompanied by abundance of nerves. The nerves and strands of other soft tissue enter the substance of the tegmentum along the line of junction of its margin with the upper surface of the articulamentum. A narrow area, perforated all over by pores, so as to have a sieve-like appearance, here intervenes between the two components of the shells, and in some shells the actual margin of the tegmentum itself is perforated. In the case of the intermediate shells, in most genera there are a pair of slits (incisuræ laterales), one on either side, in the lateral lamina of insertion; these slits lead to two narrow tracts in the deeper substance of the shell, which follow the line of separation between the area centralis and the areæ laterales of the tegmentum. These narrow tracts are permeated by numerous longitudinal canals which lodge each a specially large stem of soft tissue and nerves, which ramifies in the substance of the tegmentum. Corresponding with this tract on the under surface of the shell are a series of minute openings leading into it, through which further strands of soft tissue, possibly mostly nervous, pass

* "Beiträge zur Bildungsgeschichte der Stacheln &c. im Mantelrande der Chitonen," Zeitschr. für wiss. Zool. Bd. xvii. S. 305.

from the surface of the shell-bed into the shell, to give the general network of soft tissue. In the anterior and posterior shells there are usually a considerable number of such marginal slits, each with a corresponding tubular tract and ramifying strands of soft tissues.

The network of soft tissues contained in the canals within the tegmentum ramifies towards the shell-surface and terminates there either in eyes or in peculiar elongate bodies, which, apparently, are organs of touch. These latter are long, somewhat sausage-shaped bodies, which terminate at their free extremity in dicebox-shaped plugs of transparent tissue, which show a somewhat complicated structure.

The tegmenta of the shells of most Chitonidæ are perforated at the surface by circular apertures or pores of two sizes, arranged in more or less definite patterns with regard to one another and sometimes with regard to the eyes also.

The end plugs of the sense-organs above described lie in these larger pores. From the sides of the sausage-shaped sense-organs are given off more or less numerous fine strings of soft tissue, which, diverging, pass to the smaller pores above described and there terminate in very small plugs, just like those of the larger similar organs, but less complex in structure.

The eyes are evidently to be regarded as having arisen as modifications of some of the organs of touch above described. They are connected with the same network as terminal organs of its ramifications in the same manner, and have points of resemblance to them which are convincing as to the homogeny of the two. The soft structures of each eye lie in a more or less pear-shaped chamber excavated in the substance of the tegmentum. The stalk of the pear, which forms the canal for the passage of the optic nerve, is directed always towards the free margin of the tegmentum, whence the nerve reaches it. One side of the bulb of the pear is closely applied to the outer surface of the tegmentum, and here its wall is pierced by a circular aperture, which is covered by the cornea. The cornea is calcareous; it resists the action of strong boiling caustic alkalies, but collapses at once when treated with acid. Probably some soft tissue is present in its substance, but I have been unable as yet to find it.

The cornea in sections shows itself to be formed of a series of concentric lamellæ; its substance is continuous with the general calcareous substance of the tegmentum at its margins.

The pear-shaped cavity of the eye formed by the shell-substance is lined by a dark brown pigmented choroid membrane of a stiff and apparently somewhat chitinous texture. This membrane exactly follows the shape of the cavity, but by projecting beyond the margin of the cornea all round forms an iris of less diameter than the latter.

A perfectly transparent, hyaline, strongly biconvex lens is fitted in behind the iris-aperture. The lens is composed of soft tissue, and dissolves in strong acetic acid, gradually but completely, showing a fibrous structure in the process.

The optic nerve at some distance from the eye is a compact strand; but within the very long tube continuous with the choroid—the narrow part of the pear—its numerous fine fibres are much separated from one another and loose. The retina is formed on the type of that of *Helix*, and not, as might have been expected, that of the dorsal eyes of *Oncidium*. It is not perforated by the optic nerve, but is composed of a single layer of very short but extremely distinct and well-defined rods, with their extremities directed towards the light. Beneath them is a layer or several layers of nuclei amongst the ultimate ramifications of the nerve.

Not all the fibres of the nerve entering the eye-cavity proceed to the retina. A large number of the peripherally-placed fibres pass outside the retina all round, and, perforating the choroid at its outer margin, end at the surface of the shell, all round the area occupied by the cornea. They terminate in small plugs of tissue, corresponding to those minor organs of touch universally distributed over the shell in the smaller pores already described—being, in fact, exactly similar and identical structures with these. They apparently form a sensitive zone round each eye, and they arise from the optic nerve just as do the other minor sense-organs from the nerves of the larger organs of touch. The choroid sacs of the eye show a curious open fold or gutter leading from the bulb superficially along the stalk of the pear, recalling curiously the choroid fissure.

In some genera of the Chitonidæ eyes are entirely absent. This is the case with the genus *Chiton*. The shell in *Chiton* is perforated; the usual small and large pores and the small and large touch-organs are present, but I have as yet found no trace of eyes. I have examined especially *C. magnificus* and *C. marmoratus*. In *Molpalia*, *Maugina*, *Lorica*, and *Ischnochiton* there appear to be also no eyes so far as a cursory examination has yielded evidence to me.

The arrangement and forms of the eyes vary much in different genera, and will probably prove of great value in classification, which has hitherto proved so difficult a problem.

The genus *Schizochiton* is distinguished by having the mantle deeply notched posteriorly in correspondence with a deep median notch in the posterior shell. In *Schizochiton incisus* the eyes are restricted to single rows traversing the lines which in the intermediate shells separate the central from the lateral areas, and which correspond in position with the marginal slits and the courses of the principal nerves. There are six rows of eyes on the anterior shell, two on each of the intermediate shells, and six on the posterior shell—twenty-four rows altogether, with an average of about fifteen eyes in each, or in all 360 eyes. In the specimen examined all the rows except one have the eyes arranged in a single straight row at regular intervals, but at the base of one row there are, as an exception, two eyes side by side. There are also a very few irregularly scattered eyes on the lateral area, showing that the condition here existing is probably derived from one in which the eyes were more ancestrally diffused.

In *Acanthopleura spiniger* the eyes are irregularly scattered around the bases of the tubercles with which the surface of the tegmentum is covered, and are confined, in the specimens I have examined, to the region of the margins of the shell adjoining the mantle. The eyes in this species seem to be very liable to be broken or to flake off, in consequence of the decay of the surface-laminæ of the tegmentum. Hence those remaining on old specimens are those probably most recently formed by the mantle at the margin of the tegmentum. In decalcified tegmenta of some species I have seen eyes thus apparently in process of formation and not yet completed. In some specimens to be referred apparently to this species I have been unable to find any eyes at all. It will be necessary to examine a series of specimens of various ages to discover whether the eyes are originally more widely extended over the shell-surface or always marginal only in this species.

In a large *Corephium aculeatum*, the exposed shells of which were densely covered by a green alga, immense numbers of eyes were found when the alga was scrubbed off, and at the newest margin of the shell not yet encroached upon by the plant. The eyes are very small and their corneas are oval in outline, the long axis of the oval being directed vertically parallel with the height of the shell. The two kinds of pores are arranged in vertical parallel lines with great regularity, the large pores occurring at intervals in the lines of smaller pores. The eyes are never placed on the tubercles, with rows of which the shell is covered, and which are possibly contrivances for protecting the eyes from being rubbed and destroyed.

The eyes are present in enormous numbers. I estimate the numbers present on the anterior shell alone at 3000, counting only the younger ones, which are in good condition, near the free margin of the tegmentum, and not the older eyes, more or less destroyed by the boring of the shell by algæ and animals on the rest of the area. On the remaining shells, at a moderate estimate, reckoning, as before, only the eyes in tolerable condition, there must be at least 8500 eyes.

In *Tonicia marmorata* the eyes have the peculiarity of being sunk in little pit-like depressions of the shell-surface. This, no doubt, is a contrivance for preventing them from being worn off, and the result is that they are all retained complete in large old specimens. They are arranged in single, straight, radiating rows on the anterior and posterior shell, disposed with considerable symmetry. There are thirty-four such lines on the anterior shell in one specimen, containing about eighteen eyes each. On each lateral area of the intermediate shells there are from two to four similar rows of eyes, with a few eyes grouped irregularly also. In some forms placed in the British-Museum collection as species of *Tonicia*, there are no eyes present; these possibly will be found to require to be placed in a separate genus.

In *Ornithochiton* the eyes are not sunk so deeply in pits, but are disposed somewhat as in *Tonicia*, though the rows are not so regular. In *Chitonellus* there are no eyes and but a scanty supply of organs of touch.

I have been unable to trace the nerves supplying the shells and eyes directly to their source, although I have no doubt that they proceed from the parietal (branchial) nerve, from which I have traced numerous offsets proceeding in the required direction.

I have searched in vain for any similar eyes in the shells of *Patella* and allied genera. The tegmentary part of the shell of the Chitonidæ appears to be something *sui generis*, entirely unrepresented in other Mollusca. Its principal function seems to be to act as a secure protection to a most extensive and complicated sensory apparatus, which in the Chitonidæ takes the place of the ordinary organs of vision and touch present in other Odontophora, and fully accounts physiologically for the absence of these in the group. In some respects the arrangement of the hard and soft parts curiously resembles that existing in the Brachiopoda.

It is most remarkable that these eyes should have been missed hitherto by all writers on the shells of the Chitonidæ. The fact is due, no doubt, to their minuteness and to the fact that they are not very easily seen with a powerful lens in the dried condition of the shell in most instances. In order that they may be made most conspicuous the dried shell should be wetted with spirit, and a lens as powerful as Hartnack's no. 4 objective be used.

Dr. W. B. Carpenter* observed the perforate structure of the tegmentum in *Chiton*, but did not apparently investigate

* 'Cyclopædia of Anatomy and Physiology,' article "Shell," p. 565.

the contained soft structures. He writes, "In *Chiton* the external layer, which seems to be of a delicate fibrous texture, but which is of extreme density, is perforated by large canals, which pass down obliquely into its substance, without penetrating, however, as far as the middle layer."

My father-in-law, Dr. Gwyn Jeffreys, has pointed out to me that Costa* figures what are evidently the eyes on one of the intermediate shells of a very small species of *Chiton* (*Tonicia*) *rubicundus*. They are figured as mere black dots and referred to as fine punctuations, but their arrangement is correctly shown.

The late Dr. Gray†, in his well-known paper on the structure of the *Chitons*, wrote:—"The greater number of species have a part of the valve which is not covered by the mantle, but exposed. This exposed part consists of a perfectly distinct external coat, *peculiar, I believe,* to the shells of this family. The outer coat of these valves is separated from the lower or normal portion by a small space, filled by a cellular calcareous deposit, which is easily seen in a section of the valves."

I have prepared drawings illustrating the arrangement and structure of the eyes and other sense-organs in the shell in various genera of Chitonidæ, and hope to publish them with a more complete account of my results in the coming winter.

I beg to express my best thanks to Dr. Günther for giving me every facility in making use of the British-Museum collection. Dr. Woodward kindly went over the fossil *Chitons* in the Palæontological Department with me, but we could detect no traces of eyes in any of them. This is remarkable, since the ancient forms of the group appear to be allied to *Schizochiton*.

MISCELLANEOUS.

On the Submaxillary in Masticating Insects. By M. J. Chatin.

The maxilla in masticating insects is supported by a basal piece the functional importance of which cannot be disputed, but which possesses a still greater interest from the point of view of the morphology of the parts of the mouth and even of the appendicular organs considered generally. Nevertheless it has hardly been even mentioned by a few writers, among whom we must cite Kirby and Spence, who gave it the name of the *cardo* (hinge), a term happily enough representing its mode of articulation; Brullé gave it the name of *submaxillary*, which I here retain, so as not to introduce any neologism into an exposition already full of details.

* 'Fauna di Napoli: Animali molli, Chitone,' taf. iii. fig. 1, *e*.

† J. E. Gray, "On the Structure of the *Chitons*," Phil. Trans. 1848.

In order to acquire a sufficiently exact knowledge of the fundamental characters of the submaxillary and of the variations which it may present, it is indispensable to multiply the objects of investigation and to select them with care, not limiting observations to a few common species which have been almost exclusively studied.

Oligotoma Saundersii may be taken as a starting-point for this series of analytical and comparative investigations. Its submaxillary in fact is very simple: it has the appearance of a small piece transversely developed and rising slightly on its internal surface, where a prominence, which will soon become more strongly marked in other types, is sketched out.

In *Œdipoda cinerascens* the form is already considerably modified, chiefly as regards the configuration of its lower surface. This is not only destined to limit the submaxillary towards its base, but it has also to provide for the articulation of the maxilla considered as a whole; the ginglymus, scarcely represented in *Oligotoma* by slight sinuosities, here gives rise to the formation of deep cavities which impress a peculiar physiognomy upon this region of the submaxillary. Entomologists have long since indicated the genus *Œdipoda* as one of those in which the maxilla is most firmly articulated with the head. It will be seen that this remark fully agrees with the results of anatomical analysis.

In *Decticus verrucivorus* the general aspect undergoes further changes, the origin of which must be sought in the inner and outer surfaces, but no longer on the basal surface. Each of the lateral surfaces commences with an inferior tuberosity; then comes an excavated middle part, surmounted by an upper portion, which is very prominent, especially at the outer surface. From this results a most singular form, which can only be correctly interpreted when we examine the submaxillary isolated and freed from the surrounding parts.

This dissection, always delicate, is particularly difficult in *Gryllus domesticus*, the submaxillary of which presents an appearance which, more than in the preceding types, justifies the name selected by Kirby and Spence; the depressions and articular facets of the inferior and superior surfaces, the orientation of the piece and its relations, all concur here to form a regular hinge.

On the other hand, the articulation of the maxilla is very feebly constructed in *Phasma japetus*, in which several of the characters proper to *Gryllus domesticus* are effaced. This tendency is still more strongly marked in *Mantis religiosa*; the submaxillary, chiefly developed vertically, becomes in that species almost abnormal, and in its general conformation greatly resembles some maxillaries.

In the great green grasshopper (*Locusta viridissima*) it better displays the double part assigned to it, of securing the articulation of the maxilla and forming for it a sufficiently solid base to support the whole organ, and thus to second or even replace the maxillary. Thus the inferior surface is deeply excavated, while the transverse dimensions become more appreciable.

The relative proportions of the different parts of the submaxillary are so profoundly modified in *Hydrophilus piceus* that we have some difficulty in recognizing them, especially in a rapid examination. The inferior surface is undulated and the outer surface rather short; the inner surface presents a marked obliquity and bears a tuberosity which claims our more particular attention, because this arrangement, indicated in *Oligotoma Saundersii* &c., tends to become general in many other masticating insects.

The mandibles, as is well known, play the most active part in the division and mastication of food; but the maxillæ also assist in the operation to a variable extent according to the species, and the inferior projection of the inner surface from this point of view acquires particular importance. It did not escape Latreille, who sometimes mentions it under the name of *molar*. It is pretty constantly met with, but it presents frequent modifications. I confine myself to indicating the following:—

In *Carabus auratus* this prominence occupies an intermediate position between the lower and the inner surface; in *Forficula auricularia* it becomes conical and represents a lacerating rather than a grinding tooth; in *Blaps producta* it seems to be wanting, but its absence is compensated by a peculiar arrangement: the submaxillary considerably exceeding the maxillary, especially within, the inner surface of the submaxillary comes to project at the base of the maxillary, and may thus in its entirety fulfil the function generally reserved for the "molar" above indicated.

Although reduced to their essential points, the preceding descriptions suffice to show on the one hand all the interest that attaches to the morphological study of the submaxillary, and on the other the variations presented by this piece, which is too often overlooked, but the correct interpretation of which is indispensable in the comparative investigation of the appendicular organs in the Arthropoda. —*Comptes Rendus*, July 7, 1884, p. 51.

On a new Type of the Class Hirudineæ. By MM. Poirier and A. T. de Rochebrune.

As the crocodile lives in the water, says Herodotus, the interior of his mouth is covered with Bdellas (Lib. II. Chap. lxviii. p. 94, ed. Müller). The translators of the Greek historian, down to Scaliger, understood the word βδελλέων to refer to leeches; since then several have asserted that these animals were Diptera of the genus *Culex*. The scientific researches of one of us during a pretty long sojourn in Senegambia enable us definitely to settle a still controverted question, and to prove that the Bdellas of Herodotus must be referred to the class Hirudineæ.

The remarkable type under consideration lives attached not only to the buccal mucous membrane of *Crocodilus vulgaris*, *cataphractus*, and *leptorhynchus*, but also to the lingual papillæ of *Gymnoplax ægyptiacus* and to the interior of the pouch of *Pelecanus crispus* and *onocrotalus*.

In its general form and the presence of branchial tufts on each side of the body it approaches, at the first glance, the genus *Branchellion*; but by the peculiarities of its organization it differs from all known forms. We shall refer particularly to the following:—

Digestive apparatus.—The first part of the digestive tube presents the characters of that of the leeches with a proboscis—an exsertile proboscis, followed by an œsophagus with very thick muscular walls, of which the lumen of the canal shows a transverse lozenge-shaped section. The diameter of this organ goes on regularly increasing as far as the level of the first segment provided with branchiæ. At this point it opens into a very wide intestine with thin walls, presenting seven pairs of lobes, which ramify in the digitate branchial tufts borne by the segments of this region. The intestine is then continued into two long cæca, extending to the hinder part of the body of the animal. Between these cæca passes the very slender rectum, which bears laterally four pairs of very sinuous tubes, placed between the dorsal wall and the cæca.

As appendages of this digestive tube, which is so remarkable for its prolongations into the branchiæ, we must mention some large unicellular glands with finely granular contents placed on each side of the œsophagus, the very long excretory ducts of which penetrate into the walls of that organ, in which they ascend to a greater or less distance, and finally open into the internal cavity. These are the salivary glands.

Numerous glandular cells, probably hepatic, cover the walls of the lobate intestine.

Generative organs.—The male genital apparatus consists of four pairs of ovoid testes, situated in the last four segments with branchiæ. The epididymes, placed in the second branchiferous segment, form two cellular masses, in the interior of which the deferent ducts make numerous circumvolutions. These ducts, on issuing from the epididymes, unite in the median line to form a short unpaired spermatic duct, which penetrates into a large muscular sac, into which the very large penis can enter. The male aperture is situated in the eighth segment, or that which precedes the branchiferous segments.

The female apparatus is formed by two very long pyriform ovaries and two slender oviducts opening into a very small matrix; the female aperture is situated in the ninth segment.

Circulatory apparatus.—The circulatory, like the digestive apparatus, presents some remarkable peculiarities. The dorsal vessel furnished with sacs of the proboscis-bearing leeches does not exist. There are instead two pairs of lateral vessels, superposed, which send forth ramifications into the branchial tufts. In the digitations of these branchiæ these ramifications are placed in communication with each other by numerous transverse circular canals.

The superior lateral vessels, which we may regard as arterial, communicate with each other in each segment by an annular vessel which sends forth fine ramifications to the surface of the skin. Anteriorly these two vessels unite a little above the eyes, and emit, in front and into the thickness of the tissues, branches which unite with others, emitted by an anterior ring proceeding from the ventral vessel.

At the posterior part of the body of the animal these two lateral canals bifurcate and unite with each other by the branches thus formed; at this point these vessels emit numerous branches, which ramify upon the inferior surface of the disk and flow into a double circular vessel which runs along the margin of this disk.

Besides these lateral vessels, the circulatory apparatus includes a median ventral vessel enveloping the nervous system. At the anterior part this vessel gives origin to a ring, the ramifications of which unite with those proceeding from the two superior lateral vessels; at the hinder part this ventral vessel passes above the canals which unite the lateral vessels, and gives origin to numerous ramifications which open into the circular vessels of the margin of the disk.

Nervous system.—The nervous system, which is very like that of *Clepsine*, besides the cerebrum and the posterior mass, consists of eighteen ganglia, each formed of two pairs of large lateral vesicles, and two rather smaller ventral vesicles placed one behind the other. Each ganglion emits on each side a single nerve, which shows itself further on.

The eyes, two in number, are very large, of an orange colour and cup-like shape.

The integuments, especially in the anterior part, are very rich in large glandular cells with granular contents.

The very peculiar arrangement of the circulatory and digestive apparatus, as we have just described them, appear to us to combine a set of characters sufficient to authorize the formation not only of a genus but also of a family. This family, the position of which seems to be indicated in the neighbourhood of the Rhynchobdellidæ, we shall designate by the name of Lophobdellidæ, derived from the word *Lophobdella* (from λόφος, a tuft, and βδέλλα, a leech), which we propose as the name of the genus. The species from Senegambia and the African rivers may be inscribed under the name of *Lophobdella Quatrefagesi.*—*Comptes Rendus*, June 30, 1884, p. 1597.

On a new Type of Elastic Tissue observed in the Larva of Eristalis. By M. H. Viallanes.

There are few naturalists who have not had occasion to observe the singular movements of the respiratory tube which terminates the body of the larvæ of *Eristalis*. This tube, which is composed, like a telescope, of cylinders fitted one into the other, can, at the pleasure of the animal, be greatly shortened or lengthened to seek the air at the surface of the water. The elongation of the respiratory tube is effected by means of the contractions of the body, which drive the cavitary liquid into it. Its shortening is produced by special muscles and by elastic bands lodged in its interior.

It is to the structure of these latter parts, which, at least so far as I know, have not been investigated, that I wish now to call attention. Each of these elastic bands is a single cell, but constructed in such a way as to perform the part of a thread of india-rubber. One of these elements, examined in a half-retracted state and in the blood of the animal, presents the following characters:—its cell-body is fusiform; one of its extremities is attached to the neighbouring integuments, the other drawn out into a long process, which is likewise attached to the inner surface of the respiratory tube. The cell and its prolongation are lined with a thick but very elastic membrane. In the centre of the cell-body we observe a very large spherical nucleus; this is surrounded by an abundant protoplasm which fills the whole cell as well as its process. It must be noted that around the nucleus the protoplasm is opaque and strongly granular, while elsewhere it is transparent.

In the interior of the element that we have just described there is developed a long elastic fibre, exactly similar in physical properties to the elastic fibres which are observed in the cervical ligament of a mammal for example. It appears, in fact, under the aspect of a perfectly cylindrical refractive thread, rectilinear when stretched, curled and coiled up when left to itself; further it may be remarked that it is unalterable by acetic acid and by potash.

In the cell that we have described above the elastic fibre is coiled upon itself a great number of times around the nucleus, in the granular part of the protoplasm, and extended in a straight line into the prolongation of the cell, at the extremity of which it terminates. The elastic fibre is attached by one of its ends to the terminal extremity of the prolongation; by the other it amalgamates with and attaches itself to the protoplasm of the cell by means of a sort of branched enlargement.

When traction is applied to the prolongation of the cell the latter stretches out entirely, and at the same time the coiled portion of the fibre is unrolled; if it be left to itself it shortens, at the same time that the fibre coils up again in the cell-body.

The facts just described seem to me to be interesting upon various accounts. In the first place they prove once more to what degree of complexity a simple cell may attain; in the second, they seem to me to throw a new light upon the morphology of the elastic tissue, since they show us that in this tissue the active part, the elastic fibre, may be developed either in the intercellular substance (Vertebrata) or in the protoplasm of the cells themselves, as I have just described in *Eristalis.*

I may remark that striated muscular tissue presents analogous variations, since we see its active parts, the fibrillæ, sometimes belonging really to the protoplasm of distinct cells (striped muscular fibres of the heart), sometimes developed at the expense of the fundamental undivided substance which separates the musculogenous cells (alar muscles of insects).

Thus it would seem that one and the same tendency presides over the advance of the elastic tissue and that of the muscular tissue, since in both cases, in proportion as the advance is produced, we see the mechanically acting parts (elastic fibres, striped fibrils) quitting the protoplasm of the cells to which they belonged originally, to be developed in the intercellular substance and thus become the undivided property of neighbouring cellular elements.—*Comptes Rendus*, June 23, 1884, p. 1552.

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XX.—*On some Peculiarities in the Geographical Distribution and in the Habits of certain Mammals inhabiting Continental and Oceanic Islands**. By G. E. Dobson, M.A., F.R.S.

The geographical distribution of Mammals inhabiting continental and oceanic islands has been lately so ably treated of by Mr. Wallace, in his work 'Island Life,' that I do not purpose entering upon the subject from a general point of view, but will limit my remarks to some peculiarities of distribution which have attracted my attention while engaged in the special study of certain Mammalian orders: I refer particularly to the Chiroptera and Insectivora.

It is an interesting fact, not hitherto noticed, that many of the most characteristic species of the Chiropterous fauna of Australia have their nearest allies, not in the Oriental, but in the Ethiopian Region, thus contrasting remarkably with the avifauna. The peculiar genus *Chalinolobus* is represented only in Africa south of the equator and in Australia, a single species extending into New Zealand. Again, the species of the subgenus *Mormopterus*, which belongs to a genus (*Nyctinomus*) of world-wide distribution, are limited to the same

* Read before the Biological Section of the British Association for the Advancement of Science at the Montreal Meeting, August 29, 1884.

zoological regions, being found only in Africa south of the equator, Madagascar, the Mascarene Islands, Australia, and Norfolk Island. The presence of a species of this genus in Norfolk Island and its absence from New Zealand is very remarkable, for, as I pointed out for the first time about ten years ago, one of the two known New-Zealand bats, namely *Chalinolobus tuberculatus*, is also common in Australia.

The species of the extraordinarily specialized genus *Megaderma* have their head quarters in the Oriental and Ethiopian regions; yet the largest species, not only of the genus, but also of all known insectivorous bats, namely *M. gigas*, lately described by the writer from Central Queensland, has its nearest ally, not in any of the Oriental species, but in *M. cor* from Eastern Africa. Another very remarkable leaf-nosed bat, the type of my genus *Triænops*, found in Madagascar, Eastern Africa, and Persia, but unknown in the well-searched Oriental region, has its nearest and only ally in *Rhinonycteris aurantia* of Australia, the type of another very peculiar genus. Finally, Australia agrees much more closely with Madagascar and the Mascarene Islands than with the Oriental region in the species of the large genus *Pteropus*, for, while species of the section of which *Pt. vulgaris* of Madagascar is characteristic are well represented in the former regions, they are absent from the latter. Furthermore it is noticeable that, while 80 per cent. of the species of the genus inhabit the Australian region and Madagascar with its islands, a single species only has found its way to the great continent of Hindustan and to Ceylon.

How can we account for this resemblance of the Australian and Ethiopian regions in certain very peculiar species of bats while their birds differ so conspicuously?

In the first place, to account for the presence of closely related species in both continents, it is necessary to postulate the existence of some land connexion, not necessarily continuous, between them; but that such connexion was not by way of India appears evident from the absence of such species in that country or in the islands connecting it and the Malay peninsula with Australia.

We are therefore obliged to suppose that at a comparatively recent period a chain of islands connected these continents, the islands being sufficiently far apart to prevent the entrance of terrestrial mammals, yet near enough to permit of the occasional passage of some of the flying species; still it must be remembered that, in estimating such distances, the narrow strait between the Comoro Islands and the coast of Africa, about 180 miles wide, has sufficed to limit the western distribution of the flying-foxes, for not a single species of *Pteropus* is known from Africa, though they abound in Madagascar and the Comoro Islands. On the other hand, the insectivorous bats, with much greater powers of flight, are very similar in Madagascar and Africa.

But it may be urged that such propinquity of islands to one another and to these continents would also permit interchange of the avifaunas.

To this the following reply may be made:—That the existence of a complete chain of islands separated by sufficiently narrow straits may have existed for a short period only, the completeness of the chain being, perhaps, dependent on some volcanic group, which may have disappeared as suddenly as it came into existence. Under such circumstances bats would be much more likely to establish themselves successfully in the new continental lands open to their migrations for the following reasons:—(1) that the food of both the frugivorous and insectivorous species is of a more general character than that of birds, few of the species of which are so omnivorous, within these limits, as the bats; (2) that the nocturnal habits of the bats would enable them to escape observation from enemies always sure to recognize the presence of solitary individuals.

It may now be urged that if we acknowledge the effect of such circumstances in favouring the distribution of bats, we ought then to expect to find more bats than birds in all oceanic islands. Such an objection may be easily disposed of when it is remembered that volant insects are very scarce in all oceanic islands, whereas they are abundant in all continents, and, furthermore, that a straggling bird on arrival at an oceanic island would encounter far fewer enemies than it would meet in a continent, and, owing to its power of seeking its food on foot as well as on wing, would also be much more likely to survive than the thoroughly aerial bat.

It is, I believe, to a great extent, on this very principle, that the Chiropterous fauna of New Zealand is so limited; that, as yet, two species of bats only, represented apparently by few individuals, are known from these islands, while in the British Isles, which about equal them in extent, there are eight times the number of species, and, probably, a far greater proportion of individuals. The striking paucity of winged insects which, in other countries of corresponding climate, form wholly the food of the bats, has evidently, in a great measure, not only caused this remarkable difference, but, as I pointed out some years ago for the first time, has led to a change in the structure of one of the two species comparable to that of no other species of bat. This species, *Mystacina tuberculata*, has the claws of the pollex and toes remarkably elongated, very acutely pointed, and provided at the base of each with a small talon projecting from its concave surface near the base; the wings are peculiarly folded so as to occupy the least possible space, and they and the interfemoral membrane are preserved from injury by being encased, when so folded, in a specially thickened part of the wing and interfemoral membrane, analogous to the thickened part of the anterior wings in Hemiptera and to the elytra of the Coleoptera; furthermore, the plantar surface of the foot, including the toes, is covered with very soft and very lax integument deeply wrinkled, and each toe is marked by a central longitudinal groove, with short grooves at right angles to it, as in the species of the Gecko genus *Hemidactylus*. All these peculiarities of structure must accompany some corresponding peculiarities in the habits of this species. There can be little doubt that the denticles at the bases of the claws of the thumbs and toes give additional grasping-power to these organs, and this, taken into consideration with the peculiar manner in which the wings and interfemoral membrane are protected from injury when not employed in flying, and with the manifestly adhesive nature of the sole of the foot and inferior surface of the legs, leads me to believe that this species hunts for its insect food, not only in the air, but also upon the branches and leaves of trees, among which its peculiarities of structure most probably enable it to climb with security and ease.

The insect food of this species consists chiefly, in all probability, of the Longicorn beetles and Carabidæ, which form so large a proportion of the New-Zealand insect-fauna, and are found on and under the bark of trees. In searching for these the peculiarly mobile projecting snout is, no doubt, actively employed, while the very large scalpriform incisors are evidently most effective in seizing and crushing them. In fact, this quasi-terrestrial bat represents the only arboreal insectivorous mammal in the islands, and probably takes also the place of the insectivorous woodpeckers.

To return to the distribution of the species of the widely spread large genus *Pteropus*, with more than forty species, including the great frugivorous bats, of which *Pt. edulis* (inhabiting Java and adjacent islands) measures 5 feet in expanse of wings. These bats, as I have already remarked, have their head quarters in Australia and in Madagascar and the Mascarene Islands. It is a noticeable fact that, although the small islands of Mauritius, Bourbon, and the Comoro group have each two very distinct species, the great continent of India and Burma and the island of Ceylon has but one*. It appears probable, therefore, that India owes its single flying-fox to some other region, and, in seeking for the country from which it is derived, we must consider its nearest allies among the species of the genus.

Now this species differs from *Pt. Edwardsii* of Madagascar and the Seychelle Islands in few and unimportant characters, presenting such differences only as might have resulted in a few generations, though they now appear to be permanent. It is therefore evident that these two species have been derived within a comparatively recent period from a common ancestor, and probable that the enormous number of individuals of *Pt. medius* now representing the genus in India are the descendants of a few individuals originally escaped from their island homes in the Indian Ocean, and now cut off by subsidence of some of these islands from their nearest relations. On no other hypothesis can we account for the discontinuous distribution of the species of this genus, for, as we have seen, the narrow channel of Mozambique between the Comoro Islands and the coast of Africa has sufficed to prevent their entrance into Africa, where tree-fruit is abundant and where immense numbers of fruit-eating bats of other and of allied genera abound. Indeed it is difficult to imagine one of these great bats, whose flight appears so slow and laboured compared with that of all other species of Chiroptera, traversing 50, much less 500, miles of unbroken sea; for even if carried out to sea by a storm, their wings would evidently collapse long before they had travelled half the distance. On

* That this is not due to deficiency of food the following note by Dr. J. Anderson, F.R.S., abundantly proves, for it shows what prodigious numbers of individuals of this one species (*Pt. medius*) inhabit the country:—"This species has been flying for the last few days from the north to the south of the city (Calcutta), in immense numbers, immediately after sunset. The sky, from east to west, has been covered with them as far as the eye could reach, and all were flying with an evident purpose, and making for some common feeding-ground. Over a transverse area of 250 yards, as many as seventy bats passed overhead in one minute; and as they were spread over an area of great breadth and could be detected in the sky on both sides as far as could be seen, their numbers were very great, but yet they continued to pass overhead for about half an hour. This is not the first time I have observed this habit in this species; indeed it was more markedly seen in August 1864, while I was residing in the Botanical Gardens, Calcutta. The sky, immediately after sunset, was covered with this bat, travelling in a steady manner from west to east, and spread over a great expanse, all evidently making for one goal, and travelling, as it were, like birds of passage, with a steady purpose." ('Catalogue of Mammalia,' Indian Museum, Calcutta, pt. i. p. 101: 1881.)

the other hand, it is quite out of one's power to understand their present distribution, except on the old grounds of independent creation, without postulating a much closer connexion, than Mr. Wallace appears disposed to admit, between the island groups in the Indian Ocean at a comparatively recent period.

The above-noted facts lead to the following deductions, namely, that, in the first place, a chain of islands sufficiently close to allow of the passage, not only of the representatives of the genera of insectivorous bats referred to, but also of the large slow-flying frugivorous bats, must have existed between Madagascar and Australia; and, secondly, that, at a later period, a temporary connexion of a similar kind lay between Madagascar and India.

It may be said that such connexion with India would also permit of the introduction of insectivorous bats; but it must be again remembered that volant insects, on which such bats feed, are very scarce in oceanic islands, while tree-fruit, which forms the food of the frugivorous species, is usually abundant. Bearing these facts in mind, it is necessary to suppose that the islands, assumed to have formed the high road for the insectivorous bats between Africa and Australia, must have been sufficiently large to support volant insects; while, on the other hand, a chain of small coral islands, placed not too far apart, and provided only with a few fruit-bearing trees, would have sufficed for the passage of the frugivorous species; and it appears more than probable that it was by such a chain that the ancestors of the flying-foxes of India were introduced into that continent.

While considering the former geographical relations of these regions it may be well to refer to an apparently most remarkable instance of discontinuous distribution which long puzzled zoologists—namely, the supposed close relationship between the Insectivora of Madagascar and the West Indies, depending upon the presence, in the islands of Cuba and Hayti, of one or more species of the genus *Solenodon*, which was said to belong to the family Centetidæ, known elsewhere in Madagascar only. Mr. Wallace partly gets over the difficulty by referring to supposed remains of species of this family in France in strata believed to be of Lower Miocene age; but this was hardly necessary, for, as I have lately pointed out*, *Solenodon* belongs to a family less closely related to Centetidæ than the Hedgehogs (Erinaceidæ) are to the Moles (Tal-

* 'Monograph of the Insectivora, Systematic and Anatomical,' pt. i. p. 87.

pidæ) or to the Shrews (Soricidæ), and no zoologist has ever suggested the union of these families. The supposed close relationship depends therefore on faulty estimation of the natural affinities of these animals.

Two species of bats, *Vesperugo noctivagans* and *Atalapha cinerea*, inhabit the Bermudas, while one only, *Vesperugo Leisleri*, is known in the Azores, and its presence there is less remarkable, seeing that the latter islands are distant about 550 miles from Madeira, where this species is also found, while the former are nearly 700 miles from the American coast. The presence of these animals in both groups of islands has been attributed to violent storms; and it is worthy of notice, as tending to bear out the correctness of this theory, that the Azorean species resembles the American species inhabiting the Bermudas in the robustness of its bodily structure and in the hairiness of its wing and interfemoral membranes—qualities which would endow the animals possessing them with greater powers of resisting fatigue and of enduring the chilling effects of high winds at probably a great elevation.

XXI.—*Moas and Moa-hunters.* By A. de Quatrefages.

[Concluded from page 141.]

IV.

At the same time that he clearly distinguished the *Moa-hunters* from the *Maoris*, Dr. Haast asserted that the former confined themselves to roughly chipping their stone implements, while the latter knew how to give them a polish, of which we can judge from numerous specimens*. He added that the Moa-hunters did not possess weapons in nephrite, that is to say, fabricated out of a kind of stone often confounded with jade, to which the islanders found in New Zealand by European navigators attached a special value†.

These two propositions were of very great importance in connexion with the theory maintained by the New-Zealand naturalist. They tended to establish a further agreement with what took place in Europe. It is well known that the *chipped hache* and the *polished hache* are among the characteristic traits which, among us, distinguish two epochs. It is also well known that the populations of these two epochs belonged

* Sixth proposition, p. 140. † Second proposition, p. 140.

to different races, and that the one which was more advanced in civilization attacked and conquered that which preceded it. To find in New Zealand our two Palæolithic and Neolithic ages, characterized in the same way by instruments indicating a difference in social condition, was to introduce an important argument in favour of the ethnological distinctness of the Moa-hunters and the Maoris. But, by excavations in the Sumner cave and the neighbouring dunes, Dr. Haast himself discovered, at various times, fragments of haches and other instruments perfectly polished; and further, some uninjured specimens, similar in every respect to those which are known to be the work of the Maoris. Among these objects some were in nephrite. All of them were found under conditions which attested their contemporaneity with the men who hunted and ate the great brevipennate birds. I shall only cite a hache which was placed immediately beneath the stones forming an oven which had served for cooking Moas*. In presence of these material proofs, furnished by himself, Dr. Haast, with the most honourable candour, did not hesitate to admit that the Moa-hunters had attained a degree of civilization equal to that presented by the Maoris when Europeans first visited New Zealand†.

It is, I think, permissible to think that this equality of social development, manifested by similar characteristic industries, ought to have inspired Dr. Haast with some doubts as to the soundness of his theory. Nevertheless he has not given up any of his general ideas. He has persisted in denying the ethnical identity of the Moa-hunters and the Maoris, and in throwing back the epoch of the destruction of the Moas into a past time which he seems to regard as geological ‡.

I find no one except Mr. Colenso who has accepted this doctrine as absolute §. I have already stated that Mr. Stack

* "Researches in Sumner Moa-Cave" ('Transactions' &c. vol. vii. p. 77).

† *Ibid.* p. 80. Before Dr. Haast had given up this particular point, numerous discoveries of instruments and weapons in polished stone mixed with remains of Moas had been made in many places. I have already stated how Dr. Haast had endeavoured to explain or interpret facts of this nature, and I need not revert to this matter. The loyal and distinct declaration of the eminent geologist frees me from the necessity of entering here into any details.

‡ Haast, 'Geology of the Provinces of Canterbury and Westland, New Zealand.' See especially the thirteen propositions formulated at p. 430, and chap. xvi. (*c*) p. 437.

§ "An Account of some enormous Fossil Bones of an unknown Species of the Class Aves, lately discovered in New Zealand," in Ann. & Mag. Nat. Hist., 1844.

refuses to admit a very great antiquity for the destruction of the Moas. He also recognizes that the Maori traditions contain some allusions to these birds. In his childhood he heard talk of Moa-feathers found upon a rock where the last of these Brevipennes had concealed itself. However, he also thinks that this may perhaps have referred to feathers of Cassowaries brought to New Zealand by the ancestors of the Maoris*. We see that Mr. Stack does not regard the latter as descendants of the autochthonous Moa-hunters supposed by Dr. Haast.

Upon this latter point, moreover, the ideas of the New-Zealand geologist do not appear to be by any means fixed. I have reproduced above the terms employed by him in the conclusion of his third memoir, and have cursorily indicated how vague and contradictory they are, notwithstanding their apparent precision†. In another memoir he expresses a very different idea, and regards the Melanesian negroes as having preceded the Maoris in New Zealand, and ascribes to them the extermination of the Moas ‡. Moreover, in support of his new opinion he invokes only those very traditions which we have seen him reject in the most formal manner. Still, he only knows them from the Rev. Richard Taylor's book. It is from this that he borrows a quotation from Sir George Grey, whose classical work § he does not seem to have read. Lastly, in his geology of the province of Canterbury, he formally adopts Mr. Colenso's views, and repeatedly speaks of the predecessors of the Maoris as *autochthonous* inhabitants who lived in the Quaternary epoch. At the same time he supposes that these children of the soil of New Zealand had more or less close affinities with the Melanesians ||.

I have too often contended against this old idea of autochthonism, to render it necessary for me to revert to it here. But this conception being got rid of, I am glad to agree with Dr. Haast. The opinions maintained by the learned geologist as to the existence of two races inhabiting New Zealand before the arrival of Europeans, and as to the nature of those

* "Notes on Moas and Moa-hunters" ('Transactions' &c. vol. iv. p. 108).

† See the notes at foot of p. 140.

‡ "Notes on an Ancient Native Burial-place" ('Transactions' &c. vol. vii. p. 91). Dr. Haast has subsequently insisted upon this idea, and sought to show, by what takes place in Australia, that very inferior black tribes may very well know the processes of polishing stone ('Geology of the Provinces of Canterbury and Westland,' chap. xvi. p. 411).

§ Polynesian Mythology.

|| 'Geology,' &c., first proposition, p. 430.

two races, are perfectly well founded. Melanesian negroes really occupied New Zealand before the Maoris. Upon this point craniological investigations have confirmed what I wrote eleven years before the publication of Dr. Haast's memoir*. But this ethnical duality of the New-Zealand populations by no means implies as its consequence the destruction of the Moas by the first occupants. In Europe the Palæolithic men did not exterminate the reindeer and the chamois, nor even the urus.

To support his views and to throw back the extinction of the Moas to a past which, he says, cannot be calculated even by centuries †, Dr. Haast no less invokes the results of his excavations in the Sumner cave. He describes it as containing two layers, which, according to him, were distinctly separated. In the lower one were found ovens and numerous Moa-bones; this was formed of the remains of the repasts of the Melanesians. The upper layer, he states, presented only the shells of various Mollusca, formerly eaten by other natives who were the forefathers of the existing Maoris. Mr. MacKay, a member of the Geological Survey, who assisted Dr. Haast in his researches, has also published a note, in which he puts forward nearly the same opinions as his chief ‡.

But the clearly marked distinction, upon which MM. Haast and MacKay insist, does not occur elsewhere. At several points a mixture of shells and Moa-bones has been met with. And, further, the locality first investigated by those geologists was afterwards explored by Capt. Hutton and Mr. Booth, both of them familiar by long practice with researches of this kind. Now the facts ascertained by them contradict formally and upon several points the statements of the first explorers. Among other things, MM. Hutton and Booth most frequently found the Moa-bones associated with beds of shells; and they

* A. de Quatrefages, "Les Polynésiens et leurs Migrations" ('Revue des Deux-Mondes,' February 1864). These articles, enlarged and furnished with notes and with four maps, were afterwards collected into a volume, which appeared under the same title.

A. de Quatrefages and E. Hamy, 'Crassia ethnia,' p. 291. Among other evidences of the presence of two races in New Zealand, the Museum possesses a dried head of a Maori chief, the tattooing of which attests its origin, while the hair is purely Melanesian. I have had this engraved in a book, of which I have already spoken ('Hommes fossiles et hommes sauvages,' pp. 486, 487, figs. 171, 172).

† *Loc. cit.* ('Transactions' &c. vol. vii. p. 81).

‡ "On the Identity of the Moa-hunters with the present Maori Race" ('Transactions' &c. vol. vii. p. 98).

have further ascertained that the beds with and without bones were often differently superimposed*.

The increasing rarity of the Moas at a given point, the movements of the population which must often have been the consequence of it, the accidental association of the two kinds of food in the same repast, and the necessity of having recourse to a diet previously disdained, explain in the simplest manner the difference in the results furnished by excavations made at very adjacent points by equally competent observers. But we see that in their totality these results are irreconcilable with the interpretations of Dr. Haast.

V.

Among the propositions that Dr. Haast has sustained, those relating to the history of the dog must detain us for a time. We have seen that, in his third memoir, he admits the existence of a wild dog contemporaneously with the Moas, and absolutely denies that the Moa-hunters had domestic dogs †. Upon this latter point the New-Zealand naturalist is far from being in accord with himself. In his first researches he had found only a few bones of the dog among the remains of feasts, and he explained this scarcity by saying that this animal was only exceptionally eaten when its owner was short of provisions ‡. Here, then, he accepted the notion that the domestication of the dog was practised by the Moa-hunters. It is true, he added, that perhaps also it was killed in the chase, which supposes that the animal lived in the wild state, and it is to this latter opinion that he seems to have finally come.

But if this hypothesis were true we should have found, from time to time, the bones of the dog side by side with those of the Moas, its contemporaries. Now we have already stated that no fossil terrestrial mammal has yet been met with in New Zealand §. To this statement the dog forms no ex-

* "Moa-bones were never found unassociated with beds of shells, and although shell-beds did occur without Moa-bones, these just as often underlaid beds with Moa-bones as overlaid them" ("Notes on the Maori Cooking-places at the Mouth of the Shag River," by Capt. F. W. Hutton, in 'Transactions' &c. vol. viii. p. 105).

† Fourth and fifth propositions.

‡ "Either when its owner was short of provisions, or perhaps . . . ." (Address, *loc. cit.* p. 89).

§ In my first article on the Moas, when speaking of the small number of Mammalia found in New Zealand and the absence of fossils of animals of that class, I forgot to add the epithet *terrestrial* (*aériens*). Readers will, however, I fancy, have filled up this omission. *Aquatic Mammalia*, on the contrary, have repeatedly been found in the strata of New Zealand ception *. In fact, the bones of that animal have only been found in the ancient ovens, or among the fragments scattered around primitive kitchens. But then, in opposition to what has been said by Dr. Haast, they occur in abundance. I hardly find an excavator who has not indicated their existence, and they are always associated with bones of Moas.

Here, however, we meet with a fact which may appear singular at the first glance, and upon which the New-Zealand naturalist has repeatedly insisted. The bones of all kinds scattered in the vicinity of the ovens are very rarely gnawed†. From this Dr. Haast concludes that the Moa-hunters were not accompanied by dogs; for these, he says, would not have failed to attack the remains of their masters' repasts. But, in speaking thus, he forgets that the canine race introduced into New Zealand was essentially destined to furnish food and clothing ‡. The Maori dog, coming from the Manaia Islands, belonged to that Polynesian race which all travellers represent as living only upon vegetables, and which must have retained its ancient habits in New Zealand §.

Moreover, if some dogs took to eating meat their masters would soon have perceived that this food modified the taste

(Haast, 'Geology of the Provinces of Canterbury and Westland,' chaps. x. & xii.). I have elsewhere referred to the fact that the Cetacea play a part in the traditions of the Maoris ('Les Polynésiens et leurs Migrations,' chap. iv.), and that every animal of this kind thrown upon the shore belonged of right to the *Ariki*, the chief of the territory ('Journal des Savants,' January 1873).

* Capt. Rowan has ascertained the presence of a dog's skeleton in the hollow trunk of a tree buried in the silt of a river near Wellington Harbour. This tree was at a depth of 6 metres (about 20 feet) and beneath a layer of lignite. But beside and behind the bones there were found the hairs of the animal, with some fibres of hemp and a stalk of the same plant. It is evident that the carcass had been carried into this hole by some flood of the river, and that the event was quite recent. This has been well understood by Dr. Hector. That naturalist adds, that the burial of this dog is of earlier date than any other known ("On the Remains of a Dog found by Capt. Rowan near White Cliffs, Taranaki," in 'Transactions' &c. vol. ix. p. 243).

† The only fact of this nature that I have seen mentioned in the various memoirs written by the New-Zealand naturalists has been by Capt. Hutton. Two Moa-bones collected by his *collaborateur*, Mr. Booth, near the weirs of the Shag river had been gnawed by dogs (*loc. cit.* 'Transactions' &c. vol. viii. p. 106).

‡ "They are carrying some dogs with them, as these would be very valuable in the islands they were going to, for supplying by their increase a good article of food and skins for warm cloaks" (Sir George Grey, 'Polynesian Mythology,' p. 214).

§ The dog was called *Kuri* by the Maoris. This local race was of small size, with a brown or yellowish coat, with long ears and a bushy tail. It is now extinct and replaced by our European dogs.

of their flesh in a manner by no means agreeable, and they would not fail to watch that they kept to their habitual diet*. It is therefore quite natural that the dogs of the Maoris did not act in the same way as those which accompanied the old Danes of the kitchen-middens, and that they have not, like the latter, left the traces of their teeth upon the bones thrown away about them.

VI.

There is another very important question with regard to which Dr. Haast is not in agreement with several of his colleagues. The eminent geologist has declared many times that he has never found human bones among the fragments of repasts scattered about near the ovens; and from this negative result he concludes that the Moa-hunters were not cannibals†. But he himself admits that he has not met with them any more in the accumulations of shells incontestably left by the existing Maoris‡. Now the cannibalism of the latter is well known; and nevertheless Dr. Haast's mode of reasoning would lead us to doubt or even to deny it. This simple remark deprives Dr. Haast's argument of all value.

However, in both cases, this absence of human remains is easy to understand. It is not when engaged in the chase or in fishing quietly for shell-fish that the most anthropophagous tribe feeds upon human flesh. For the commission of an act of cannibalism under such conditions as these, leaving on the ground pell-mell bones of man and the Moas, nothing but some absolutely exceptional circumstance would account.

But, notwithstanding Dr. Haast, this fact has occurred repeatedly. Mr. Walter Mantell first ascertained this in the North Island§, and his testimony is one of those that we can the least challenge. This able and persevering investigator discovered in the valley of the Wanganui some hillocks, covered with turf, which the natives declared to be formed by the remains of the feasts of their ancestors. On excavating them he found that they were composed of bones of Moas, dogs, and men confusedly intermixed. All these bones had evidently under-

* The flesh of our European dogs, all of which eat more or less meat, has a peculiar taste, reminding one of the odour of an ill-kept kennel. With this the siege of Paris made us only too well acquainted.

† Seventh proposition.

‡ *Loc. cit.* 'Transactions' &c. vol. viii. p. 74.

§ "These consisted of Moas', dogs', and human bones promiscuously intermingled" ("On the Fossil Remains of Birds collected in various parts of New Zealand by Mr. Walter Mantell," by G. A. Mantell, F.R.S., in Quart. Journ. Geol. Soc. vol. iv. 1848, p. 234).

gone the action of fire. Dr. G. A. Mantell also tells us that Mr. Taylor had met with similar hillocks in the valley of Whaingaihu. These observations are not isolated. In the northern part of the North Island, at the Pataua river, near Wangarei, Mr. Thorne discovered, side by side with remains of ancient Maori-ovens, a mixture of shells, ashes, pieces of charcoal, and bones of seals, fishes, men, and Moas, which had evidently served as a repast for the natives *. Mr. Roberts has also found some human bones mixed with those of the Moa and with charcoal, side by side with stones formerly employed in cooking them†. Lastly, Mr. Robson has made analogous observations in the neighbourhood of Cape Campbell ‡. Thus, contrary to Dr. Haast's assertions, the Moa-hunters *were* anthropophagi.

VII.

I have just examined Dr. Haast's principal propositions, those which most directly touch the special question which is the subject of this study. They are not much in accordance, as will be seen, with precise facts upon which doubt can hardly be thrown. This is the case also with what he advances with regard to the absence of local traditions relating to the Moas §. As long ago as 1848 Dr. Mantell announced to the Geological Society of London that his son had found near Wellington the very distinct recollection of these birds, larger than a man, which were formerly very abundant in the country, and that some of the oldest Maoris even asserted that they had seen some of them ||. Later on, in 1870, Sir George Grey, in reply to a first memoir by Dr. Haast, wrote a letter to the Zoological Society of London, in which he affirmed that twenty-five years before (*i. e.* in 1845), the natives always talked to him of the Moas as having been well known to their ancestors. He added, that the Maori poems contain numerous allusions to these birds¶. In 1875 Mr. Hamilton published a conversation which he had held with an old native, who said that he had seen the last of the

* "Notes on the Discovery of Moa and Moa-hunters' Remains at Pataua River, near Wangarei," by G. Thorne ('Transactions' &c. vol. viii. p. 85, pl. iii.)

† "Notes on some Ancient Aboriginal Caches near Wanganui," by H. C. Field ('Transactions' &c. vol. ix. p. 220).

‡ "Further Notes on Moa-remains," by C. H. Robson ('Transactions,' vol. ix. p. 279).

§ Second proposition.

|| *Loc. cit.* p. 26.

¶ "Letters of Sir George Grey," cited by Dr. Haast, in his Address, p. 100.

Moas, and who described it so as to impress vividly his English interlocutor *. Among other things this Maori described the curvature of the neck with an exactitude of which a well-informed European might judge, but the elements of which could only be furnished to a savage by the observation of the living animal. I could multiply these testimonies, but I shall confine myself to borrowing some details upon this subject given to Mr. Travers by Mr. White in the letters which I have already cited †. Even then it could be seen, and it will be still more visible here, that far from being vague and obscure, the traditions in question are remarkably precise.

"The Maoris," writes Mr. White, "were afraid of it [the Moa], as a kick from the foot of one would break the bones of the most powerful brave‡; hence the people made strong spears of 'Maire' or Manuka wood 6 or 8 feet long, and the sharp end of which was cut so that it might break and leave 6 or 8 inches of the spear in the bird §. With these the men would hide behind the scrub on the side of the track, and when the birds were escaping from the fear of the noise of those who had driven them from the lakes, those spears were thrown at them, thus sticking in the bird; the scrub on the sides of the track would catch the spears and break the jagged end off, leaving it in the bird. As it had to pass many men the broken spear-points thus put into the bird caused it to yield in power when it had gained the open fern-country, where it was attacked in its feeble condition by the most daring of the tribe."

The Moas when killed were cut up with a particular variety of obsidian named *Tuhua Waiapu* ‖. The Maoris brought with them a block of this stone and detached from it flakes, which only served a single time, were not employed in cutting any other flesh, and were abandoned on the spot.

* "Notes on the Maori Traditions of the Moa," by J. W. Hamilton ('Transactions' &c. vol. vii. p. 121).

† 'Transactions' &c. vol. viii. p. 79.

‡ Mr. Travers adds, in a note, that a hill situated on the eastern coast bears the name of a chief who, having pressed too closely upon a wounded Moa, received a kick which broke his thigh and made him roll to the bottom of the hill. We see how all these popular reminiscences agree.

§ The Maoris, like all the Polynesians, were unacquainted with or disdained the use of the bow.

‖ Mr. White tells us that the Maoris distinguished three kinds of obsidians, characterized by their colour. That which was used for cutting up the flesh of the Moa was of a light colour; another, of a green colour, *Tuhua panetua*, was used by the natives to wound themselves in their funeral ceremonies. When the deceased was a chief or a child, and when human flesh was to be cut up, they employed the third kind, *Tuhua kahurangi*, the colour of which is red.

Before proceeding to the chase when Moas were to be attacked, the Maoris pronounced one of those *incantations* or prayers which with them preceded all actions of more or less importance. Mr. White was unable to remember the terms exactly, but he gives the sense of one of them, and tells us that the mists of the hills* where the chase was to take place are supplicated so to act that the fat of the birds may flow like the drops of dew which fall from the leaves of the trees at the dawn of a summer-day; and the god of silence is prayed to keep the Moas free from apprehension and fright.

The last Moa-hunt of which the memory is preserved, according to Mr. White, took place in the North Island, in the neighbourhood of Whakatane, in the Bay of Plenty. The feathers of the birds killed there were, until recently, in the hands of a chief named Appanui†.

Several material facts testify to the truth of the details given by Mr. White. Thus all the memoirs relating to excavations executed near the ancient *Moa-ovens* mention flakes of obsidian which had evidently served to cut the flesh of those birds; and all of them remark upon the great number and the close resemblance of these primitive knives. Mr. Thorne has, moreover, found one of those blocks which the Maoris carried with them as a matter of precaution, and recognized, by the quantity of fragments, the point where the temporary manufactory of these instruments was established ‡. At an elevation of 4000 feet, on a mountain-plateau near Jackson Bay, Dr. Hector has discovered numerous tracks cutting in all directions through a dense thicket. These tracks

* It is evident that the *Spirits of the mists* are here referred to. Contrary to assertions which have been too often repeated, the Maoris had a very complicated mythology and a very numerous Olympus, although, perhaps, not so well hierarchized as that of the Tahitians (see Mœrenhout, 'Voyage aux iles du grand Océan'). Of this, the publications of the New-Zealand *savants* are bringing fresh proofs every day. Among others, the natives believed in a kind of *goblins*, gnomes, or sylphs, whom they represented as innumerable, and to whom they attributed the great part of their good or ill fortune. It was therefore necessary on every occasion to render them favourable. Hence arose that multitude of prayers or invocations which are constantly spoken of in the Maori traditions. Upon all these questions the following works may be consulted with advantage :—Grey, 'Polynesian Mythology;' J. F. Wahlers, "Mythology and Traditions of the Maoris" ('Transactions' &c. vol. viii. p. 108); Colenso, "Historical Incidents and Traditions of the Olden Times, now for the first time faithfully translated from old Maori Writings and Recitals" (*ibid.* vol. xiii. p. 38, and vol. xiv. p. 3); Colenso, "Contributions toward better knowledge of the Maori Race" (*ibid.* p. 33); Taylor, "*Te ika a Maoui*, or New Zealand and its Inhabitants."

† Mr. White adds the name of another known individual, and enters into details which it is unnecessary to reproduce here.

‡ *Loc. cit.* p. 86.

were not the work of man; they are well beaten and about 16 inches wide. They are so many runs such as wild animals make, and, being in New Zealand, they are necessarily the work of birds. From the height of the thicket they could only have been made by animals much larger than the kiwis (*Apteryx*), which alone traversed them at the time of Dr. Hector's visit, the imported mammals not having as yet penetrated so far*. Do not these tracks answer perfectly to the idea that one is led to form of those in which the Moa-hunters lay in ambush? and their state of preservation would seem to attest that they cannot have been abandoned for centuries.

VIII.

But the most decisive proof of the recent disappearance of the Moas is furnished by the repeated discoveries of bones to which the soft parts, the muscles and integuments, still adhere. At least three† well-attested examples are known. The colonial museum possesses a portion of a neck, the origin of which I have not found mentioned anywhere‡. In 1871 Mr. Low announced to Dr. Hector that he had just sent to him a piece of Moa's flesh bearing down and many quills of feathers§. Nearly at the same time Dr. Thomson obtained from a gold-prospector, who had discovered them in a cave and under an accumulation of mica-schist, the bones of a Moa to which ligaments, muscles, and some fragments of skin still adhered. The portion of neck above mentioned formed part of this find, and was sent to Dr. Hector, who carefully figured and described it||.

In these various specimens the soft tissues appear to have undergone no alteration; they are only much dried. The flesh is not at all fossilized and its fibres can easily be de-

* "On recent Moa-remains in New Zealand," by J. Hector ('Transactions' &c. vol. iv. p. 119). Dr. Hector's visit to the mountains in question took place in 1863.

† [The York specimen of *Dinornis robustus* makes a fourth (see note, p. 132), here again passed over in silence, although parts of the skin of the feet were actually figured by Sir Richard Owen in the sixth volume of the 'Transactions of the Zoological Society,' the remains of feathers were described and figured by myself in the 'Proceedings' of the same Society for 1865, and a translation of the Abstract of the latter paper appeared in the 'Annales des Sciences Naturelles.'—Tr.]

‡ Haast, third paper, *loc. cit.* p. 102.

§ Note added to Dr. Hector's memoir, p. 114.

|| "On recent Moa-remains in New Zealand" ('Transactions' &c. vol. iv. p. 111, pl. v.).

tached*. Mr. Millen Coughtrey, to whom the objects collected by Dr. Thomson were sent, anatomized the neck, and was able to recognize the different muscles; on the right femur he found the fibres and the tendons of nine muscles; the other bones only presented traces of tendons †.

In reply to the objections to his theory which spring from the preceding facts, Dr. Haast asserts that the bones of the neck, described by Dr. Hector, are in a state of semi-fossilization, like that presented by most Moa-bones; and he explains the persistence of the muscles and integuments by their accidental position in a layer of dry sand ‡. But can we imagine how the bones could be fossilized while the flesh remained intact? Moreover, on the first point, the learned geologist is formally contradicted by Dr. Hector, who represents these same bones of the neck as being in a perfect state of preservation, and not at all fossilized §. Mr. Low makes the same assertion with respect to the specimens in his possession. How can we doubt the correctness of these statements in presence of the fact that the muscles adhering to these bones could be dissected?

Dr. Haast, indeed, replies to observations of this kind, that in Europe bones dating from the Quaternary epoch have sometimes shown a remarkable degree of preservation. He cites particularly the facts ascertained by MM. de Ferry and Arcelin, at the Clos-du-Charnier, where the bones and antlers of the reindeer had retained the greater part of their gelatine ||; but he forgets that none of these bones ever exhibited the least trace of muscles or tendons. At Solutré, as wherever fossil bones have been collected, the soft parts have totally disappeared.

It is precisely the preservation of these soft parts that gives to the remains of Moas studied by Dr. Hector their great historical significance. Moreover, it is evident that there must have been some exceptionally favourable circumstances to account for a portion of the muscular and cutaneous tissues having escaped destruction, while the greater part of them disap-

* Low, *loc. cit.*

† "Notes on the Anatomy of the Moa-remains found at Earnscleugh Cave," by Millen Coughtrey ('Transactions' &c. vol. vii. p. 141). To judge from the details given by Dr. Thomson, all the material in the way of muscles and skin contained in this cave was not collected (see Dr. Hector's memoir, *loc. cit.* p. 112).

‡ Additional notes, p. 93; Third paper, p. 102.

§ "Without being in the least degree mineralized" (*loc. cit.* p. 114).

|| "L'âge du Renne en Mâconnais" (International Congress of Prehistoric Archæology, 1868), quoted by Dr. Haast, in 'Geology of Canterbury and Westland,' p. 442.

peared. But it seems to me impossible to imagine a set of conditions, naturally produced, capable of preserving these tissues for centuries under the circumstances which its insular position imposes upon New Zealand *.

Thus every thing concurs to make us regard the final extinction of the Moas as having taken place at no very distant period. There is nothing opposed to our accepting as true the statements collected by Sir George Grey and by MM. Mantell, White, and Hamilton. On the contrary, if we suppose that some of these great Brevipennes were still living about a century ago, we can explain without difficulty several perfectly well-ascertained facts which are incompatible with Dr. Haast's theory, such as the existence of tracks still easily recognizable, the preservation of fragments of flesh and skin, &c. Now it is towards this date that the information collected by Mr. Hamilton carries us back. Haumatangi, the old Maori of whom he speaks, was one of the oldest of his compatriots in 1844. He said that he saw Cook†. We know that that illustrious mariner rediscovered New Zealand, which had been almost forgotten since Tasman's time, on October 6, 1769. Haumatangi was therefore more than seventy-five when he was interrogated by Mr. Hamilton, and not seventy only, as the author is made to say by some printer's error. If we suppose that he was about twelve years old when he observed the large bird which he remembered so well, New Zealand would have still had living Moas about 1770 or 1780.

* This is also the opinion of M. Alphonse Edwards, to whom the functions with which he is charged at the Muséum, and his researches upon fossil birds, give a particular authority in the question now under consideration. The following is what he has been kind enough to write to me upon this subject:—"Dr. Haast ('Geology of the Provinces of Canterbury and Westland') refers, in support of his theory, to the discoveries made in Siberia of entire carcasses of mammoths whose death dates from Quaternary times. On this point I do not share in Dr. Haast's opinion; for if animals can be preserved indefinitely in the constantly frozen soil of Asia, this is not the case in New Zealand, where, throughout the historical period, the temperature has been very mild and the humidity considerable. These conditions must have facilitated the putrefaction of carcasses, whatever may have been the natural conditions of their entombment."

† Dr. Haast invokes, in favour of his views, the silence of Cook on the subject of the Moas; but it is evident that at that time they had nearly disappeared. Now as the coasts were everywhere populated, the last of these great birds could hardly have been found except in the interior, and it is quite simple that the great English mariner would receive no information about them. The same observation applies still more strongly to the travellers who came after Cook, and whose silence is also appealed to by Dr. Haast in support of his theory ('Geology of the Provinces of Canterbury and Westland,' chap. xvi.).

IX.

Hitherto, to my regret, I have had to oppose Dr. Haast. I am only the more pleased to bear testimony to the incontestable services which he has rendered to science in solving some of the most interesting questions which are raised by the history of the Moas. From his investigations, equally fertile and persevering, it appears that all the large and small Brevipennes which have inhabited and still inhabit New Zealand were contemporaneous. In exploring the alluvial deposits and the marshes of Glenmark, the learned geologist found, side by side, bones of *Apteryx* and remains of the largest and most curious species of Moas, just as with us the bones of the mammoth and rhinoceros are found mixed with those of the reindeer and the chamois*.

As with us also, the extinction of the lost species did not take place at the same time. If there are some which survived to the close of the eighteenth century, others perished at more or less remote periods. Further researches, hitherto too much neglected by the New-Zealand naturalists, will be necessary to determine the succession of these extinctions; and in order to solve the many questions raised by this problem, archæology and geology must come to each other's aid. Dr. Haast seems to me to be the only person who has already collected some data upon this subject, and for this we owe him our thanks †.

From the surveys published by the eminent geologist it appears that the bones of *Dinornis giganteus* have never been met with among the remains of feasts in the vicinity of the ancient ovens. The largest of birds would seem therefore to have ceased to exist before the arrival of man in New Zealand. Dr. Haast has only once found the remains of a *Dinornis robustus* among the refuse of a kitchen. This species, little inferior in size to the preceding, was probably near disappearance when the hunters killed one of its last representatives in Shag Valley. At Rakaïa have been collected the remains of three specimens of *Palapteryx ingens*, the bones of which had been intentionally broken; but this bird has not been met with elsewhere. *Palapteryx crassus* has occurred very abundantly at Shag Valley and Rakaïa. *Pala-*

* 'Geology, Glenmark,' chap. xvi. (D), p. 442. Dr. Haast estimates at over a thousand the number of Moas of which the remains have been obtained from this locality, from which the greater part of the specimens which have enriched the museums of the whole world have been derived.

† Address, p. 86; Third paper, p. 97; 'Researches in Sumner Moa-Cave,' p. 85; 'On a Moa-Encampment,' p. 99.

pteryx elephantopus has been met with in the same two localities, but in smaller quantity than the preceding.

We see that man has eaten some of the largest and most remarkable species of Moas. However, he seems to have soon exterminated them. None of those just mentioned has occurred at Point Cave. They are replaced there by the species of *Euryapteryx* and *Meionornis*, especially by *Meionornis didiformis*, which the natives, although sometimes killing it, seem to have disdained so long as they could hunt *Palapteryx* *.

I place here in the form of a table the results of the excavations made by Dr. Haast in some localities where man has eaten the Moas, adding the indications given by the author as to the greater or less abundance of the bones belonging to the different species:—

Genus Dinornis.

D. robustus (Shag Valley, a few bones).
D. gracilis (Rakaïa, dominant).
D. struthioides (Rakaïa, dominant).

Genus Palapteryx.

P. ingens (Rakaïa; three individuals).
P. crassus (Shag Valley, dominant; Rakaïa, many).
P. elephantopus (Shag Valley, fewer; Rakaïa, few).

Genus Meionornis.

M. casuarinus (Shag Valley, very few; Rakaïa, dominant; Point Cave, 15·05).
M. didiformis (Shag Valley, very few; Rakaïa, many; Point Cave, 53·03).

Genus Euryapteryx.

E. rheides (Shag Valley, dominant; Point Cave, 49·01).
E. gravis (Shag Valley, fewer; Point Cave, 33·03).

Thus about two thirds of the species of Moas hitherto recognized have been met with in the remains of the feasts of the natives.

If the Maoris had hunted the Moas only by means of the processes described by Mr. White, it is very probable that Europeans would have been able to observe some species of

* Letter from Mr. W. H. G. Roberts ('Transactions' &c. vol. vii. p. 548).

these great Brevipennes for themselves. But besides these much more powerful means were employed against them. Nooses, in which they caught themselves, were placed in their runs*; immense battues, in which the whole population was associated, were organized; the birds were driven towards a lake, into which they threw themselves in despair, and where hunters in canoes killed them without difficulty †. Lastly, they went so far as to invest them with fire by burning vast tracts of forest, when they must have perished by hundreds, often without any profit to the incendiaries. In this way may be explained the fact noted by Mr. Taylor and various other reporters, who speak of whole fields covered with hillocks formed by the bones of Moas ‡. It may be added that the Maoris were very fond of their eggs. Fragments of the shells of these have been found almost everywhere and sometimes in immense numbers.

Thus pursued to extremity and attacked even in their reproduction, the Moas evidently could not but disappear; but their extinction is certainly recent. In maintaining the opposite opinion and supposing that the total destruction of these large birds dates back to an epoch as ancient as our European neolithic times, Dr. Haast has deceived himself. He has been led astray by purely geological analogies, perhaps more apparent than real.

At any rate, we cannot establish any true assimilation between the zoological facts which have occurred in Europe and in New Zealand. The Quaternary fauna of New Zealand was entirely of local origin; it was otherwise here. The mammoth and the rhinoceros were immigrant animals, driven by the cold of the northern regions of Asia towards warmer countries §. The extinction of these species must have been hastened by the action of a medium quite different from that in which they had originated, and by the profound changes of climate which they had to support towards the close of the glacial epoch. Nothing of the kind took place in New Zealand. The Moas were there truly autochthonous; they never quitted their original centre of creation; in their conditions of existence they underwent only inconsiderable modifications, as, indeed, is very well shown by Dr. Haast himself ||.

* Taylor, quoted by Travers ('Transactions' &c. vol. viii. p. 77).

† Roberts, *loc. cit.* ‡ Taylor, *loc. cit.*

§ Murchison, de Verneuil, Keyserling, and d'Archiac regard the mammoth and the tichorhine rhinoceros as having lived in Siberia during the Tertiary epoch. According to Lartet the reindeer was their companion.

|| Address, *loc. cit.*, and 'Geology,' *passim.*

The spontaneous extinction of these birds is therefore very difficult to understand. Nevertheless we must admit that natural causes were opposed to the indefinite duration of certain species. To judge from the known facts, it seems to be demonstrated that the largest species of *Dinornis* was no longer in existence when man reached these isolated lands in the midst of the ocean. The other species of the same genus and those of *Palapteryx* appear to have been very rare at this epoch, and not to have long survived the arrival of the hunters; they were consequently in process of natural decrease. On the contrary, the individuals of *Meionornis* and *Euryapteryx* seem to have been very numerous before the moment when the war of extermination, carried on with such improvidence, commenced*. In consequence of geographical conditions they could not emigrate like the reindeer, and their mode of life prevented them from seeking a retreat in the midst of the glaciers, as the chamois has done with us. They were consequently annihilated, but only in modern days, like the Dodo and those other birds of the Mascarene islands, of which M. Alphonse Edwards has recast or completed the history †.

XXII.—*On two Species of* Alveolites *and one of* Amplexopora *from the Devonian Rocks of Northern Queensland.* By Robert Etheridge, Jun., and Arthur H. Foord, F.G.S.

[Plate VI.]

Introduction.

The interesting species described below form part of a collection of Corals lately received by one of us from Mr. R. L. Jack, F.R.G.S. &c., Government Geologist for North Queensland. The localities given on the instructions accompanying the specimens are Regan's, Philp's, and Benville's

* The following shows, according to Dr. Haast, in what proportion the various species of Moas are represented at Glenmark:—*Meionornis casuarinus* alone represents one fourth, and *M. didiformis* one fifth, of the total number of individuals discovered. Then come, in decreasing numbers:—*Palapteryx elephantopus*, *Euryapteryx gravis*, *Palapteryx crassus*, and *Euryapteryx rheides*; *Dinornis gracilis*, *struthioides*, *maximus*, and *robustus* occur in nearly equal numbers. *Dinornis ingens* is represented only by a few individuals.

† "Recherches sur la faune ornithologique éteinte des îles Mascareignes et de Madagascar," by Alphonse Milne-Edwards, 1866–79.

(?) allotments, on the Northern railway, 31 miles from Townville. They are said to have been collected on a "limestone reef." The interest of the collection generally lies chiefly in the fact that it may be looked upon as supplementary to that described by Prof. H. A. Nicholson, M.D., and one of the writers in 1879 ('Annals,' 1879, ix. pp. 216, 265), from the Burdekin district. The appearance of the specimens is peculiar, and would at first sight give rise to the impression that they were of a travelled nature, as they are much eroded and with their angles rounded. A closer examination, however, leads to the conviction that they are only portions of the limestone-reef much weathered, and perhaps worn by the action of running water. This view is borne out by the appearance here and there of the coral projecting above the surface of the blocks, in a fine state of preservation, and weathered clear of the matrix. The external colour of the masses is bluish grey, but on a fractured surface the limestone is seen to be black, or deep bluish black, and very crystalline. This latter circumstance has rendered a satisfactory examination of the corals, even by means of thin sections, very difficult, and in some cases almost impracticable.

Genus ALVEOLITES, Lamarck, 1801.

(Syst. des Anim. sans Vert. p. 375.)

[Emend. Nicholson, 1879.]

Alveolites alveolaris, de Koninck, sp. (Pl. VI. figs. 1–1 *c*.)

?*Billingsia alveolaris*, de Kon. Recherches sur les Foss. Pal. de la Nouv. Galles du Sud, Brussels, 1876–77, p. 75, pl. ii. figs. 4, 4 *a*, 4 *b*.

Sp. char. The corallum in this species is massive and apparently lobate. The corallites are minute (about two in the space of 1 millim.), closely contiguous, of considerable length, their walls somewhat thick; the apertures of the cells present an irregularly lunate form, and in some of them a single tooth-like septum may be detected. The tabulæ are well developed, horizontal, or a little curved, and tolerably numerous. The mural pores are large, and consist of a single series placed at pretty regular intervals of about half a millim. apart.

Obs. The highly crystalline condition of the specimens representing this species has rendered its determination very difficult. The specimens occur in the shape of weathered masses in which some parts harder than the rest stand out in relief and exhibit tolerably well the structures described above, though these were studied more effectively by means of microscopic sections. One of the specimens has the surface (of which only a very small portion is preserved) studded with small conical elevations, about 1 centim. apart measured from their summits. Of the significance of these we are unable to form an opinion. We do not know of their occurrence in any other species of *Alveolites.*

Three species of *Alveolites* have been recorded from the Devonian rocks of Australia. Of these, one only (*Alveolites subæqualis*, Edwards & Haime) need be compared with the present form, and the much smaller corallites of the latter afford sufficient grounds for their separation.

In his 'Rech. sur les Foss. Pal. de la Nouv. Galles du Sud,' M. de Koninck instituted a genus, under the name of *Billingsia*, for a Devonian coral from the neighbourhood of Yass, New South Wales, which the author describes as apparently devoid of tabulæ ("Les planchers semblent faire défaut") and as possessing lateral openings in the walls of the corallites resembling those of *Syringopora*, except that in *Billingsia* the walls are closely united, and not separated from one another as they are in *Syringopora.* We are of opinion that M. de Koninck has entirely misunderstood the structure of this coral. The figures given by that author (see pl. ii. of the work above cited) accord remarkably well with our form; and although he states in his description that tabulæ are wanting, they appear to be shown clearly enough in fig. 4 of his work, which we reproduce (fig. 1, *d*).

Assuming, then, that the *Billingsia alveolaris* is identical with the Queensland specimens, we are of course unable to accept M. de Koninck's suggestion that the present species is transitional between *Aulopora* and *Syringopora.*

Locality and Horizon. Regan's allotment, Northern railway, 31 miles from Townsville, North Queensland. Devonian.

Collection. Geological Survey of North Queensland, Townsville, N. Q.

Alveolites alveolaris, var. *queenslandensis*, Eth. & Foord.
(Pl. VI. figs. 2–2 *b*.)

This form differs from the one described above chiefly in the size of the corallites, which are considerably larger than those of *A. alveolaris.* The present form appears to be branching and lobulate, and occurs in large weathered and rounded fragments, one of which measures about 12 centim. in its greatest length, and about 6 centim. in thickness, but the specimen must have been considerably larger when perfect. Scarcely any of its surface remains, and microscopic sections do not yield very satisfactory results, on account of the extensive mineral alteration that the fossil has undergone.

In their longer diameter the corallites measure about two thirds of a millimetre, in their shorter about one third, or even less. The tabulæ are somewhat numerous, horizontal or oblique, and sometimes curved, and in some places they anastomose. Mural pores large and apparently numerous.

Locality and Horizon. Regan's allotment, Northern railway, 31 miles from Townsville, North Queensland. Devonian.

Collection. Geological Survey of North Queensland, Townsville, N. Q.

Genus AMPLEXOPORA, Ulrich, 1882.

Amplexopora Konincki, Eth. & Foord.
(Pl. VI. figs. 3–3 *c*.)

The present species, like the others from the same locality, has undergone a good deal of alteration by weathering and by crystallization, so as to obscure, in a measure, the structure of the organism. It was apparently a massive form. The calices are polygonal in outline, with the angles rounded; minute and variable in size, somewhat thin-walled; from three to four occupy the space of 1 millim. Spiniform corallites may be seen in transverse sections at the angles of junction of many of the cell-apertures. The corallites are well shown on portions of the specimens in which the matrix that filled them has been removed by weathering. In a longitudinal section the tabulæ are seen to be remarkably regular in their disposition, and are placed horizontally in the tubes, from one to two tube-diameters apart. The filling in of the coral is calcite of fibrous structure (arragonite?), the fibres cutting the walls of the corallites, as well as crossing the visceral cavities.

Obs. It was not until a close examination had been made of thin sections of this species that we were able to arrive at a definite conclusion as to its affinities; and in this respect material assistance was rendered us by the careful observations of the artist, Mr. A. S. Foord, to whose skilful hands the execution of the plate had been entrusted.

We were at first under the impression that it might be a *Chætetes*, but the presence of the spiniform corallites set this question at rest. Not the least interesting fact is the discovery of this genus at a new geological horizon, giving to it a much greater geographical distribution.

We beg to associate with this species the mame of Prof. L. G. de Koninck, of Liége, the renowned Belgian palæontologist.

Locality and Horizon. Regan's allotment, Northern railway, 31 miles from Townsville, North Queensland. Devonian.

Collection. Geological Survey of North Queensland, Townsville, N. Q.

EXPLANATION OF PLATE VI.

Fig. 1. *Alveolites alveolaris*, de Kon., sp. Portion of a specimen, showing the elevations upon the surface. Enlarged twice.

Fig. 1 *a.* Portion of another specimen, showing the mural pores. Enlarged about 25 times.

Fig. 1 *b.* Transverse section of this specimen. Enlarged about 25 times.

Fig. 1 *c.* Longitudinal section. Enlarged about 25 times.

Fig. 1 *d.* Copied from pl. ii. fig. 4, 'Foss. Pal. Nouv. Galles du Sud,' by L. G. de Koninck.

Fig. 2. *Alevolites alveolaris*, var. *queenslandensis*, Eth. & Foord. Transverse section. Enlarged about 25 times.

Fig. 2 *a.* Longitudinal section of the same species, showing pores. Enlarged about 25 times.

Fig. 2 *b.* Another longitudinal section, showing the tabulæ. Enlarged about 25 times.

Fig. 3. *Amplexopora Konincki*, Eth. & Foord. Portion of the surface, enlarged about 50 times.

Fig. 3 *a.* Transverse section. Enlarged about 50 times.

Fig. 3 *b.* Transverse section. Enlarged about 25 times.

Fig. 3 *c.* Longitudinal section. Similarly enlarged.

XXIII.—*Crustacea of the 'Albatross' Dredgings in* 1883. By Sidney I. Smith*.

Very little has yet been published in regard to the zoological results of the deep-sea explorations carried on during the summer of 1883, by the United States Fish Commission, although the dredgings were among the most important yet made. Some of the remarkable forms of fishes discovered have been described by Drs. Gill and Ryder, but the writer's report on the Decapod Crustacea (eighty pages of text with ten plates), recently put in type for the Fish Commission Report for 1882, is the first detailed report on the zoological collection made by the 'Albatross,' and affords an opportunity for a brief review of the results of the study of the higher Crustacea, which is here published by permission of the Commissioner of Fish and Fisheries.

The dredgings of the 'Albatross' extended from off Cape Hatteras to the region of George's Banks. The number of dredging-stations was 116, of which 30 were in less than 100 fathoms, 35 between 100 and 500 fathoms, 19 between 500

* From the 'American Journal of Science,' July 1884, pp. 53–56.

and 1000 fathoms, 27 between 1000 and 2000 fathoms, and 5 below 2000 fathoms. The whole number of species of Decapoda determined from these stations is 72, but of these at least 15 are true shallow-water species. Of the remaining 57 species, 40 were taken below 500 fathoms, 29 below 1000 fathoms, 13 below 2000 fathoms, and 6 at a single haul in 2949 fathoms. Of the 29 species taken below 1000 fathoms, 21 are Caridea or true shrimps, and the eight higher species are distributed as follows:—2 Eryontidæ, 3 Galatheidæ, 1 Paguroid, 1 *Lithodes*, and 1 Brachyuran belonging to the Dorippidæ. It is interesting to compare these results with the lists of the fauna of the North Atlantic below 1000 fathoms, given by the Rev. Dr. Norman in the presidential address to the Tyneside Naturalists' Field-Club, published last year. In Dr. Norman's lists only 12 species of Decapoda are recorded, none of them from as great a depth as 2000 fathoms, and of these 12 species 7 were known only from the 'Blake' dredgings of 1880.

The following are some of the more interesting new forms:—a new genus of Brachyura allied to *Ethusa*, 1496 to 1735 fathoms; an Anomuran belonging to A. Milne-Edwards's new genus *Galacantha*, 1479 fathoms; two species of *Pentacheles* (a genus of Eryontidæ, allied to *Willemoesia*), between 843 and 1917 fathoms; a stout Palæmonid (*Notostomus*), 6 inches long and intense dark crimson in colour, 1309 to 1555 fathoms; a gigantic *Pasiphaë*, 8½ inches long, 1342 fathoms; three species of a remarkable new genus allied to *Pasiphaë*, and also to *Hymenodora* and some other genera of Palæmonidæ, which shows that *Pasiphaë* is closely allied to the Palæmonidæ; a large Penæid, 1 foot in length, referred to the little-known genus *Aristeus*; and a large *Sergestes* 3 inches in length.

The great size of some of these new species of shrimps is remarkable, but is far exceeded by two of the previously described crabs. *Geryon quinquedens*, from 105 to 588 fathoms, is one of the largest Brachyurans known, the carapax in some specimens being 5 inches long and 6 broad; while one specimen of the great spiny *Lithodes Agassizii* measures 7 inches in length and 6 in breadth of carapax, and the outstretched legs are over 3 feet in extent.

Among the Schizopoda there are two large species of *Gnathophausa*, one over 4 inches in length, and a *Lophogaster*, all from below 2000 fathoms. One of the most interesting Schizopods is a small *Thysanoessa* (a genus of Euphausidæ) from 398 to 1067 fathoms, of which one female was found carrying eggs. The eggs are carried in an elongated and flattened mass beneath the cephalothorax, are apparently held together by some glutinous secretion, and are attached principally to the third pair of pereiopods (antepenultimate cephalothoracic appendages). This apparently confirms Bell's statement in regard to the egg-carrying of *Thysanopoda Couchii*, which is, as far as I know, the only published observation of egg-carrying in any of the Euphausidæ.

The Amphipoda from deep water are comparatively few in number and have not yet been carefully examined; but among them is one specimen of the gigantic *Eurysthenes gryllus*, Boeck (*Lysianassa Magellanica*, Milne-Edwards), probably the largest of all known Amphipoda. This specimen, which is over 4½ inches long, and very stout in proportion, was taken in 1917 fathoms, north lat. 37° 56′ 20″, west long. 70° 57′ 30″. The few previously known specimens came from Cape Horn, Greenland, and Finmark, and have apparently all been taken from the stomachs of fishes. This species and its occurrence in the extreme arctic and antarctic seas have been much discussed and form the subject of a long memoir by Lilljeborg; but the apparently anomalous distribution is explained by its discovery in deep water off our middle Atlantic coast.

The great differences in depth through which some of the species range is worthy of notice, several species ranging more than 2000 fathoms, as shown in the list, given further on, of species taken below 2000 fathoms. I have not yet noticed distinct varietal differences due to depth in any species, though there is often a very marked change in the associating species. A very remarkable case is that of *Parapagurus pilosimanus*, which was taken at fifteen stations, and in 250 to 640 fathoms, by the 'Fish Hawk' and 'Blake,' in 1880–81–82, and in great abundance at one station in 319 fathoms, where nearly 400 large specimens were taken at once. All these earlier specimens were inhabiting carcinœcia of *Epizoanthus paguriphilus*. In the dredgings last summer the *Parapagurus* was taken at seven stations ranging in depth from 1731 to 2221 fathoms; but none of the specimens were associated with the same species of *Epizoanthus*, some being in a very different species of *Epizoanthus*, others in naked gastropod shells, and still others in an actinian polyp.

A striking characteristic of the deep-sea Crustacea is their red or reddish colour. A few species are apparently nearly colourless, but the great majority are of some shade of red or orange, and I have seen no evidence of any other bright colour. A few species from between 100 and 300 fathoms are conspicuously marked with scarlet or vermilion, but such bright markings were not noticed in any species from below

1000 fathoms. Below this depth orange-red of varying intensity is apparently the most common colour, although in several species, very notably in the *Notostomus* already referred to, the colour was an exceedingly intense dark crimson.

The eyes of these abyssal species are even more remarkable than their colours, as the following list of the Decapoda and larger Schizopoda taken below 2000 fathoms by the 'Albatross,' with the notes which follow, will show:—

	fathoms.
1. Parapagurus pilosimanus..........	1731 to 2221
2. Pontophilus abyssi	1917 to 2221
3. Nematocarcinus ensiferus	588 to 2030
4. Acanthephyra Agassizii	105 to 2949
5. Acanthephyra, sp.	2929
6. Genus allied to Acanthephyra	1395 to 2929
7. Hymenodora glacialis	888 to 2030
8. Parapasiphaë sulcatifrons	516 to 2929
9. Parapasiphaë compta	2369
10. Amalopenæus elegans	640 to 2369
11. Aristeus ? tridens	843 to 2221
12. Hepomadus tener.................	2949
13. Sergestes mollis	373 to 2949
14. Gnathophausa, sp.	858 to 2033
15. Gnathophausa, sp.	959 to 2949
16. Lophogaster, sp.	1022 to 2949

In every one of these sixteen species the eyes are present, in the normal position, and distinctly faceted. In nos. 3, 4, 5, 6, 11, and 12 the eyes are well developed, black, and, while somewhat smaller than in the average Palæmonidæ and Penæidæ, not conspicuously smaller than in many allied shallow-water forms. In 1 the eyes are black, but conspicuously smaller than in the allied shallow-water species. In 13 the eyes are black and of moderate size. In 9 they are apparently black or nearly black and small. In 2 they are nearly colourless in alcoholic specimens and rather larger than usual in the genus, but considerably smaller than in *Pontophilus gracilis*, a very closely allied species found in 200 to 500 fathoms. In 7 and 8 they are small and light coloured. In 10 they are rather small and dark brown. In 14, 15, and 16 they are not conspicuously different in size from those of allied shallow-water species and are dark brown.

However strong may be the arguments of the physicists against the possibility of light penetrating the depths from which these animals come, the colour and the structure of their eyes, as compared with those of blind cave-dwelling species, show conclusively that the darkness beneath 2000 fathoms of sea-water is very different from that of ordinary caverns. While it may be possible that this modification of the darkness of the ocean abysses is due to phosphorescence of the animals themselves, it does not seem probable that it is wholly due to this cause.

The large size of the eggs is a marked feature in many of the deep-water Decapoda. The eggs of *Eupagurus politus* from 50 to 500 fathoms are more than eight times the volume of those of the closely allied and larger *E. bernhardus* from shallow water; and in *Sabinea princeps*, from 400 to 900 fathoms, they are more than fifteen times as large as in *S. septemcarinata* from 25 to 150 fathoms. The most remarkable cases are among the deep-water genera. *Galacantha rostrata* and *G. Bairdii*, from between 1000 and 1500 fathoms, have eggs 3 millim. in diameter in alcoholic specimens, while in the vastly larger lobster they are less than 2 millim. The largest Crustacean eggs known to me are those of *Parapasiphaë sulcatifrons*, a slender shrimp less than 3 inches long, taken between 1000 and 3000 fathoms. Alcoholic specimens of these eggs are fully 4 by 5 millim. in shorter and longer diameter, fully ten times the volume of the eggs of *Pasiphaë tarda* from 100 to 200 fathoms, more than 350 times the volume of those of a much larger shallow-water *Palæmon*, and each one more than a hundredth of the volume of the largest individual of the species. From the peculiar environment of deep-water species it seems probable that many of them pass through an abbreviated metamorphosis within the egg, like many freshwater and terrestrial species, and these large eggs are apparently adapted to produce young of large size, in an advanced stage of development, and specially fitted to live under conditions similar to those environing the adults.

XXIV.—*Notes on Sponges, with Description of a new Species.* By Stuart O. Ridley, M.A., F.L.S., &c.

The following remarks are either based on specimens recently added to the collection in the British Museum, or suggested by the study of the collection.

Monactinellida.

Chalinidæ.

Cladochalina diffusa, n. sp.

Cladochalina diffusa, Ridley, Report on the Zoological Collections made during the Voyage of H.M.S. 'Alert,' p. 672, pl. xli. fig. D, *d*, *d'*.

Suberect, branching subdichotomously in one or more parallel planes; branches tortuous, more or less compressed, sometimes forming broad expansions terminated by subcylindrical prolongations, simple or branched; greatest diameter of terminal branches about 10 millim. Surface either approximately even, or echinated by few and sharp vertical projections, 1–2 millim. high. Vents numerous, opening flush with surface, and entered at a slight depth by the openings of the excretory canals; diameter 1–1·5 millim., scattered at intervals of 3–7 millim. over the anterior surface of the branches. Consistency in spirit firm, but compressible and elastic; in dry state firm, but harsh to touch, and but slightly compressible and elastic: colour in spirit bright ochreous brown, in dry state pale grey. Main skeleton approximately rectangular in arrangement; primary fibres about ·4 millim. apart at surface, where they terminate vertically in the dermal reticulation, diameter about ·1 to ·14 millim.; secondary fibres vertical to primaries, about ·3 millim. apart, diameter ·07 to ·1 millim.; fibres of both kinds consisting of a compact axial mass of spicules, and of a margin of transparent pale amber-yellow horny substance about ·025 millim. broad. Dermal skeleton forming subquadrate meshes ·18 to ·36 millim. in diameter, formed of spiculo-fibres, which are usually devoid of any visible horny margin, and range in thickness from ·025 to ·1 millim. Sarcode pale amber-yellow, subtransparent. Spicules smooth acerate, slightly curved, tapering to sharp points from within about two diameters of ends, size ·11 by ·0063 millim.

Hab. Singapore, between tide-marks.

This species was obtained by H.M.S. 'Alert,' and figured in the 'Report' &c. (*l. c. suprà*), but not described.

The largest specimen, which is dry, is very irregularly rooted, and near its base shows the palmate development of the stem and branches very strongly; it measures 190 millim. (7½ inches) greatest lateral, and 95 millim. (3¾ inches) in greatest present height; its branches are almost smooth, but those of the younger spirit-specimen show the aculeation above described. Both specimens deviate from the erect habit in the turning of the branches outwards and to the sides soon after they are given off.

The fibre is stronger and stouter than in any *Cladochalina* with which I am acquainted, and gives the species the firmness of a *Pachychalina*; in the tendency to become flattened it also resembles that genus.

The variation in the character of surface aculeation exhibited by this Chalinid is important and significant in relation to its value in classification.

Axinellidæ.

Echinodictyum mesenterinum.

Spongia mesenterina, Lamarck, Ann. Mus. Hist. Nat. xx. p. 444.
Echinonema vasiplicata, Carter, Ann. & Mag. Nat. Hist. 1882, ix. p. 114.

This fine species has been described under the above two names. I have already stated (Report on the Zoological Collections made during the Voyage of H.M.S. 'Alert:' London, 1884, p. 454) that Mr. Carter's species is referable to *Echinodictyum*, mihi. Examination of a specimen in the Museum at the Jardin des Plantes, Paris, which agrees with Lamarck's description, has shown me that that species is identical with the former.

Suberitidæ.

For the view that the Suberitidæ are really Monactinellid and Monaxonid, derived from a Diactinellid type, and not reduced Tetractinellids, evidence is afforded by the heads of the spicules of the species described below. In those heads which (as in many other species) exhibit a small terminal rounded process or knob, the central canal shows a small inflation near the centre of the larger division of the head, and a fine undilated prolongation in the direction of (but scarcely extending into) the small process, apparently indicating that the spicule was originally prolonged on both sides of the present head, the small terminal knob of the head and the fine prolongation of the central canal being rudiments of the second ray. An additional argument in favour of this view is the fact that the projection and its corresponding section of central canal occur in young spicules, and tend to be lost in adult examples.

Suberites massa, Schmidt, var.

As the original form of this species has (like, indeed, most known species of *Suberites*) never been fully characterized, I think it well to describe some interesting specimens from Mauritius, which differ from the originals only in their external form.

Sponge massive, consisting of vertical convolutions or sinuous laminæ, about 45 millim. ($1\frac{3}{4}$ inches) high, and 10 millim. thick above, appressed towards each other, dividing and uniting with each other; they are rounded above and rise to approximately the same height. General appearance that of the human cerebrum. Vents scattered, subcircular, about 1 millim. in diameter, placed low down on the sides of the convolutions at some distance below the top of the sponge.

Colour, in dry state, orange-brown. Skeleton—composed of long, imperfectly separated bands of the skeleton-spicule, massed closely together and parallel in direction, extending from the base towards the apex of the lobes composing the sponge, beneath the layer which forms the immediate surface. Dermal layer consisting of short spicular columns, ·4–·6 millim. in height, arising vertically or obliquely to the surface, where the spicules spread out so as to form, by the lateral divergence of their apices, brushes, which are in contact with each other laterally; between the bases of these brushes are placed the chones of the inhalent canal-system. Spicules—spinulate, smooth, head oval to globular, a small basal rounded prolongation in nearly all spicules, except those fully adult, where it appears usually to be wanting; neck moderately distinct; shaft normally straight, tapering to a sharp point from near middle: size—main skeleton ·8 millim. by ·019 millim. (both head and shaft), dermal skeleton ·6 by ·013 (head), ·0095 millim. (shaft). Internal soft tissues transparent and pale amber-yellow in the dried state.

Hab. Adriatic (*Schmidt*); Mauritius (*coll. Mus. Brit.*).

This form agrees in every essential particular of its minute structure with Adriatic specimens.

Mr. Carter (Ann. & Mag. Nat. Hist. ser. 5, ix. 1882, p. 351) records from Mauritius a *Suberites*, as "massive, growing into short branches on the surface; colour ochre-yellow." He says it is undescribed, but shortly afterwards states that it will probably be found to be identical with the above species.

The laminæ in the present specimens appear to be more or less distinct from the base upwards. The total height of the sponge is about 60 millim. ($2\frac{1}{2}$ inches); horizontal extent of the largest specimen (apparently not quite perfect) 110 by 78 millim. ($4\frac{1}{2}$ by 3 inches).

Since the above description and remarks were written, another specimen of this species has been received, also from Mauritius, which is composed of similar vertical laminæ; these, however, instead of being closely appressed by their sides, are distinct from each other, with the exception of junctions caused by uniting trabeculæ of sponge-substance; thus the common portion of the sponge forms a honeycombed mass with wide fenestræ; above, the vertical plates project freely in the form of flat plates, sometimes of considerable extent, or of narrow finger-like lobes, closely resembling those of the Adriatic specimens of the species now in the British Museum. In this second Mauritius specimen the subglobose form of the head of the spinulate is the commonest, and the horizontal bundles of spiculo-fibre are not so well marked as in the cerebriform variety.

Spirastrella pulvinata.

Hymeniacidon pulvinata, Bowerbank, P. Z. S. 1872, p. 126.

As the spiculation and other characters of this species agree with those of Schmidt's genus *Spirastrella*, I have labelled the magnificent specimens on which the species is based, now in the British Museum, as above.

TETRACTINELLIDA.

Corallistes parasitica.

Arabescula parasitica, Carter, Ann. & Mag. Nat. Hist. 1873, xii. p. 464.

An immense specimen, about 19 inches wide, 11 inches high, was acquired for the National Collection from Mauritius some little time since. It has the general form of a single somewhat folded cabbage-leaf. It is attached by a short distinct submedian stem, 35 millim. high, 75 millim. wide across the front, 35 millim. from back to front; the frond itself ranges from 10 to 15 millim. in thickness. When perfect, the greater part of the margin appears to have been sharp, and uninjured remains of it have a pinched-up appearance.

When attached, the frond probably was suberect, the upper half being recurved so as to form an angle of about 60° with the basal portion. The whole of that side which thus becomes the upper side is beset with small conical vents, about 1 millim. high, ·6–1 millim. wide at their mouth, distributed at intervals of from 2 to 4 millim.; in most cases they may be seen to be entered, at about 1 millim. below their margins, by a number of secondary excretory canals. The opposite surface of the frond is covered with similar but smaller openings, slightly prominent, about ·3 millim. wide at the mouth, arranged in sinuous series, about 1 millim. apart, the openings of those of the same series being almost in contact with each other. The external and minute characters of this fine species, now that they are fully known, agree well with those of *Corallistes*. To Carter's account of the spicules may be added that a flesh-spicule, bow-shaped or somewhat sinuous, minutely roughened, and measuring ·019 millim. long by ·0017 millim. thick, occurs very abundantly in the dermis.

XXV.—*On the Hard Structures of some Species of* Madrepora. By Prof. P. Martin Duncan, F.R.S., V.P.L.S., &c.

The object of this examination of three species of the genus *Madrepora* is to afford information regarding the nature of the growth of the colony, of the method of the gemmation, and of the development of the septa. The communication also refers to the porosity of the forms, as well as to their different endothecal structures.

It was found to be advisable to stain the specimens with carmine, so as to obviate the glare of light.

Two of the three species are known; but as only portions of the colony of the first one which will be noticed are in my possession, it is necessary to give a brief description of it.

First species:—

Colony large, branching, with long, slender, pointed branchlets, which have ramuscules on their flanks of from 0·5 in. to 1·5 in. in length. Colony very proliferous. Apical corallites sometimes 5 millim. in length, circular at the margin, with a wide calice, showing one cycle of well-developed septa and sometimes a second cycle.

The apical corallite has much porous mural structure around the calice. The secondary corallites exist all around the axial ones, are numerous, long (3 millim.), tubuliform, outwardly curving, very porous, costulate, and faintly nariform. Immersed calices are rare. The costæ exist, but are confused upon the surfaces at the bases of the secondary corallites, where there is a very decided spinulation. Gemmation is frequent, and is noticed on the apical and the secondary corallites.

The locality is Madagascar.

It is evident, from the general appearance of the specimens, that they were very vigorous and rapid growers, the hard parts being perfectly well developed, but thin, and, except in old parts, not thickened with an extra deposition of carbonate of lime. The number of young buds is great, and the porous tissue around the older corallites is delicate and well seen.

The surface of the corallites is costulate and echinulate, and the costæ are very regularly disposed, in rows, down the outside of the corallites, from the calicular margin to the general surface, where they become confused. They are subequal, thin, lamellar, and plain at the free edge in some parts, but exceedingly spinulose in others. They project regularly and equally from the wall of the corallites, and are imperforate. The intercostal spaces are broader than the costæ; but these last project more than the breadth of the interspaces.

The wall is seen at the bottom of the intercostal spaces and it is very regularly fenestrated, the openings being large, longest longitudinally, and rarely circular or elliptical in outline. The solid portions of an entire space are less in extent than the area occupied by the vacuities.

The solid portions of the wall, seen at the bottom of the intercostal spaces, are joined, on either side, to the base of the costæ, where the costal laminæ arise from the outside of the corallite. In most parts the costal laminæ are plain at the sides and solid; but here and there a trabeculate appearance is seen, owing to the existence of small arched vacuities in them close to the intercostal perforations. Moreover, where there are spinules on the free surface of the costæ, a trabeculate appearance is given by a somewhat indefinite structural connexion between the solid cross pieces of the wall and the spinules at the free edge.

It must be understood that in these descriptions the term "wall" only refers to the outer layer of the mural structure, which is made up of this and one or many more layers of similar structure. The apical corallites have many layers of wall in their mural structure, and the secondary corallites have usually only one layer, or a wall, which increases in thickness at the "nariform" part. The wall is simple on the corallites, remote from the nariform process, and is very perforate near the calice, the costæ often projecting as trabeculæ. The "nariform" process is not seen in many young corallites, and it is not invariable in older secondary ones. The apical calice is never "nariform."

Frequently, and when growth appears to have been very rapid, the cylindrical and rather outward-turning corallites are composed of only one layer of mural tissue, and the costal laminæ are almost plain at their free edges. A few very small spinulose serrations or dentations are seen on the costæ at some distance from the calicular margin, and some lax, semi-vesicular sclerenchyma exists at and in the neighbourhood of the bases of the smaller corallites, and where they arise from the axial or parent one.

A different appearance is, however, presented on most of the corallites, for exogenous growth and gemmation are very common. Then there are always spinules and dentations on the free edges of the costæ, a little remote from the calicular margin, and either very distinct spinules on the surface around the bases of the corallites, or the lax tissue is greatly developed there.

The spinules are larger on the surfaces around the bases of the corallites than elsewhere, and they are the foundations of the lax tissue which is the first stage of exogenous growth. Moreover they occasionally assist in the production of buds. On the corallites the spinules are small, except where they are about to enter into the formation of buds or mural tissue.

The formation of mural tissue is part of the interesting exogenous growth, and it can be examined amongst the lax structures at the junction of the corallites with the central or axial corallite. The spinules form the props, or uprights, on the top, over which a thin film of calcareous tissue grows gradually, and stretches from the top of one spinule to that of the others close by. Here and there the tops will be seen slightly flattened, and elsewhere the flattening extends, so that the tops are united by a fragile arch which unites with those of others, and tends to form an irregular discontinuous roofing.

This kind of growth proceeds from and on the top of all the spinules, and a space is thus covered in and a new outer surface is seen. The floor of this space is the old wall with its perforations, the supports are the spinules, and the roof is the new growth, which is porous on account of the irregular development of the films. A similar growth occurs on the corallites, especially at the outer part of the margin in young corallites, and all around the calice in old and apical ones; but in these instances the costæ assist as well as the spinules, for growths can be traced from them outwards, which become the origin and supports of arching-over trabeculæ, and thin filmy plates that will sooner or later produce a roof, or, in other words, part of a new wall. A development of spinules often takes place on the costal edge near the calicular margin, and thread-like growths stretch from one to the others along the costæ; they lay the foundation of a new costa.

Two kinds of growth appear to occur, after the development of the new part of the wall: in one case spinules grow from it, and costal laminæ are produced in the manner just mentioned, an exact repetition of the former state of things coming to pass; and in the other irregular, long, straight, ragged growths occur from all parts of the new surface, and combine to form a lax and porous structure.

The amount of spinulation, or rather of true denticulation, on the edges of the costæ, in some parts of the colony, is so great that the parts, were they detached, would be considered to belong to a different variety. It is in these parts, however, that gemmation is rapid and frequent, and exogenous growth very decided and regular.

When transverse sections of a branch or budding twig of a colony are made, one is impressed with the exceeding toughness of the very fragile-looking coral, and with the very regularly concentric exogenous method of increase. Concentric circles of thin calcareous structure are seen separated by radiating linear pillars; the circles having been, in turn, outside walls, and the radii either spinules or costæ.

If the coral is old, the circle of calcareous tissue immediately around the septal cavities is dense, and so also may be a second or a third circle; but if the coral is growing rapidly, the circles are less defined, of thinner substance, and less regularly arranged. Moreover the nature and appearance of the radiating structures differ according to the rapidity of growth, and the original lamination or spinulation of the costæ. Some sections show very solid laminated costæ passing up through the concentric mural circles and terminating externally, in free costal edges, with or without spinules upon them. Other sections exhibit a more confused radiation of short, crooked, slender costæ; and near the surface of the coral very distinct tall spinules are separate, conical, and support the last produced film of mural tissue.

There is always a quantity of concentric mural tissue around the apical or terminal corallite, which is visible around its calice. This structure may be mainly composed of costal lamellæ, united by fine, concentric, and often irregular plates; or the tissue may be so spongy in appearance that it is difficult to make out any definite concentric and separately radiating layers.

Under both conditions, however, the deficiency of pores or perforations in the costal structures is very much opposed to the popular idea of a perforate coral.

It is well known that when sections are made through a moderately thick branch of a colony, several buds are cut across at varying distances around the axial corallite. The direction of the buds is outwards and forwards, and the inference is very naturally drawn that the buds were continuous with the axial corallite's cavity; but transverse section after transverse section may be made and yet no such conjunction of young and old corallites be discovered. By using the steel nippers carefully, and after making longitudinal sections, the independence of the buds of the miscalled parent or axial corallite can be well seen; moreover, it then becomes apparent that interstitial calcareous growth has diminished the original area of the perforations, or vacuities, of the corallite-wall.

Besides, in this longitudinal view, the singularly imperforate condition of the septa is very visible. The principal septa are lamellar, straight or wavy, and projecting; the free edge may be thin and wavy, but in the species under examination it is not ragged, trabeculate, or spinulose. What perforations there are in the septa are small, distant, regularly placed, and are in continuation with the openings between some elongate dentations on the septal edge. Considering what has been written by some palæontologists about perforation of the septa being a characteristic of the section Perforata, it is necessary to remark that imperforate septa are the rule in all those species of the genus *Madrepora* that I have examined.

The Growth of Gemmule Sclerenchyma.

The growth of new gemmules takes place from the outside of the axial or apical corallite, from the external surface of the corallites which were buds and have elongated, but rarely from the surface opposed to the apical corallite, and also from the surfaces around the bases of the corallites. In no instance do the gemmules of this species arise from the calicular margin, and their starting-point is remote from it. Moreover, the minuteness and evidently recent development of the originating gemmule proves that the calicular margin has not grown in advance since budding commenced, so as to separate the bud from the calicular margin.

Gemmation from a Secondary Corallite.—The first appearance of a bud is accompanied by a trabeculate growth from the free edges of two adjacent costæ; the trabeculate growth is thin and arches across the intercostal space, covering it in and closing it, and forming a little hood, looking towards the free end of the corallite. Dentations then arise from the free edges of the costæ on either side of the first two, and these new growths increase in size and join the hood-like structures by bending over and forming a ragged arch. Other costæ, on either side, are subsequently implicated in this process of hood-making in a similar manner, and a small, perforate, low-arched hood with a ragged open margin covers two or three intercostal spaces, with their original perforate spaces and no others. The costæ remain for a greater or less time, and then appear to become absorbed; or one, the median, may remain and occupy the position of a septum.

The growth of the bud resembles that of new mural tissue from the costæ and spinules during exogenous growth; and it is evident that when gemmation occurs from the new mural growth the same simple arching-over of trabeculæ into a low hood occurs. But there is this difference: in the case of the budding from the outside of a corallite which only has a simple wall, the small perforations in it are direct communications between the so-called parent and the cavity of the bud; but when the bud arises from the top of many layers of mural tissue the interspaces in the sclerenchyma do not by any means form a direct communication between the two cavities. In fact no such communication exists, except in a very indirect manner, and through the medium of the dermal structures.

In the transverse sections through an axial corallite and some surrounding buds, these can often be traced to the outside of the original or first wall of the apical corallite, with which they communicate through the ordinary pores, and it may be noticed that a quantity of exogenous sclerenchyma surrounds the bases of the buds.

The hood of the bud having attained the length and breadth of 0·5 millim., faint traces of costæ are to be seen upon it, and these delicate laminæ often take the line of the costæ, which are towards the base of the parent corallite. At this stage there is not a trace of a septum within the bud.

The formation of the trabeculate wall occurs first of all, then costæ begin to develop, and it is not until the bud has increased in length that traces of septa are to be seen.

The first sign of a septum is a row of delicate spinules, and it passes straight down the inside of the bud, commencing at some distance, however, from the opening. There may be two rows of spinules, or traces of all the primaries may become apparent almost at the same time. One row is almost invariably larger than the others, and is placed towards the outer part of the cavity, or rather at the remotest point from the wall of the parent.

The next phase of growth is the elongation of the bud, the forward growth of the future calicular opening by production of the terminal trabeculæ. This is followed by a growth upon the parent wall in front of the hood-like structure, and the completion of the circle of the calicular opening, the bud thereafter growing with its front or forward part free from the parent, from which it gradually diverges in direction.

As growth proceeds the young corallite increases slightly in size and breadth, and a little more mural tissue is usually developed on the outer lip of the calicular opening; but still the septa are deeply seated, and all except the larger or the two opposite primaries, are minute and spiniform. Very frequently the two larger and opposite septa become lamellar, from the growth of calcareous matter between the spinules, and the four other primaries remain very slightly developed and still spinulose in character.

There are more costæ than septa, and they do not always correspond, the septa often arising from along other lines than those of the direction of the costæ, or they may spring from two spots and unite to form the trabecule along the line of which arise the septal spinules.

The junction of the opposite primaries may occur, or they may only approximate towards the opening of the calice; very generally the inner ends of the septa have a few trabeculate processes joining them.

When the new corallite is completed, the primaries are well developed, and there are six small spinulose secondaries at the calicular margin. The two opposite primaries are always the largest, except in the apical corallites. Thickening of all the mural structures then occurs, and in time budding will take place from the new corallite-wall, and of course remotely from the calicular margin.

The secondary corallites never attain the dimensions of mural, or fulness of septal, structure which characterize the axial or apical corallite. The axial corallite has a margin which is circular in outline and not nariform; the mural structure is spongy in appearance, although formed of successive exogenously growing layers. The septa are well developed, there being six nearly equal primaries, some with slightly spinulose inner edges, and six secondary septa which do not reach the centre of the corallite and have spines on the free inner edge.

It will be of importance to study the soft parts of the two kinds of corallites, for the impression left on the mind is that the apical calices are much better suited for the presence of mesenteries than the secondary corallites.

In this species the budding is remote from the calicular margin; the wall of the bud is formed before the septa, which are preceded by the costæ; there is no special opening between the cavity of the bud and the parent, and the bud may arise from sclerenchyma remote from the wall of a corallite. Finally the porosity of even the rapidly growing coral is diminished by the comparative solidity of the costæ and septa, and by the calcareous deposition that occurs after a certain stage of growth is passed.

On the growth of "Immersed" Corallites.

Second species:—

The species of *Madrepora* noticed above has a few immersed calices, visible at the bases of the branchlets, which are the openings of deeply seated corallites; but their relations to the surrounding structures are not well seen. It is therefore necessary to seek a better example in an allied form.

A specimen of a peculiarly growing *Madrepora*, from Madagascar*, exhibits the required structures very plainly.

The colony is large, flat, with a thick central expansion terminating circumferentially in short, thick, coalescing branches, covered above with numerous secondary branchlets which are very proliferous. The upper surface of the central part has many low, stout, and a few taller, sharp-pointed, proliferous branchlets, and at their bases and all around them are somewhat sunken surfaces crowded with immersed calices. There are others on the branchlets and around the little crowds of buds which give them an irregular appearance.

On the back of the colony the number of calices gradually diminishes from the ends of the branchlets to the centre, where they are few, wide apart, and some on low oblique projections, and the others are immersed and small.

There is a considerable difference between the immersed calices on the under and upper sides of the colony. Those on the first-mentioned surface are very small, wide apart, and present no septa at the slightly raised margin, which usually has some well-developed spinules close to it; whilst those on the upper surface are often crowded, slightly raised at the margin, and have six septa visible, but small, not projecting far into the calice, and some are not made up of lamellæ, but consist of a series of spinules.

The lower calices are the terminations of short corallites, and they pass (in the normal direction of the colony) outwards and downwards, from the proximity of long corallites which traverse the thickness of the dense central part of the colony, running towards the periphery, and keeping nearer the lower than the upper surface.

The calices on the upper surface are continuous with corallites which are long, nearly straight, curving deeply down only near to the long corallites that are in relation with the lower corallites. These upper corallites are separated by small amounts of sclerenchyma, the nature of which is very interesting, for it explains the method of the simultaneous growth of the colony as a whole, and of the corallites also.

The corallites of the immersed calices are close, and their walls are well defined in longitudinal sections. Between the neighbouring corallites, the colligating structures are in successive layers, or storeys, of laminæ separated by rows of small, irregular, and short pillars. The laminæ are stout and somewhat curved, and the pillars may be stout or slender, this last condition being noticed near the surface of the colony, and the other lower down in the mass. The nature and origin

* Probably a variety of *Madrepora cytherea*, Dana.

of this laminate-and-pillar structure is readily understood after the superficial structures of the colony, both on the upper and lower surfaces, have been examined with care. On the upper surface, and between the calices, are numbers of minute, short, broad-based, sharply pointed spinules, placed rather closely and arising from a perforated calcareous lamina, which forms the outermost structure of the coral.

By breaking away some part of this layer and its covering of spinules a somewhat similar set of structures is to be seen beneath, for the tops of small spinules, arising from a more or less perforated surface, then become visible, and they are evidently the relics of a former outer surface. Much calcareous matter has been, as a rule, added during development to the outside of the old laminæ and spinules, and their relations to the existing outer structures is more or less hidden; but on the lower surface of the coral the successive growth of several laminæ and spinules, one over the other, is plainly exemplified, the resemblance of the under and the upper layers being exact.

The method of growth can be appreciated by examining the surface of the coral beneath. There the spinules, in many places, are enlarged at the top, a calcareous tissue extending on all sides from them. This tissue joins with that forming on other spinules, and an imperfect and somewhat irregular lamina results and covers over the old surface and its spinules.

The porosity of the laminæ is due to the incomplete growth of the calcareous film arising from the tops of the spinules; but it is lessened with age and calcareous deposition. The corallites which have immersed calices must grow in length in order to keep pace with the exogenous growth of the colony; but it is very probable that the simultaneous growth is inevitable and part of the necessary development, for there is every reason to believe that the spinulation has to do with the superficial water-system common to the whole colony, and which determines the symmetrical general growth.

It was stated above that the walls of the corallites are well developed, and it also appears that they are by no means highly perforated; on the contrary, the openings are few and far between, and there are no large spaces by which buds can communicate with the so-called parent, according to some ideas.

As in the former instance, the buds arise on the layer of tissue surrounding the elder corallite, are developed out of the superficial growth incident to exogenous growth, and have no other communication with the interior of the previously existing corallite than the ordinary porosity.

It is interesting to note that the corallites of the immersed calices usually have well-developed tabulæ stretching across them completely, in spite of the septa, and that they are tolerably regularly spaced and numerous.

Third species :—

The examination of a species of *Madrepora*, also from Madagascar, confirms the statements regarding the exogenous growth, its relation to the so-called ornamentation of spinules, the non-origin of buds from the calicular margin, the absence of any unusual perforation in the wall of the parent corallites for the origin of buds, and the comparatively solid laminate nature of the principal septa.

The species is *Madrepora granulosa* of MM. Milne-Edwards and Jules Haime (Hist. Nat. des Corall. vol. iii. p. 156, 1860).

It is not necessary to mention the specific details which are given in the work just mentioned, but only to remark that the very granular under part of the colony is remarkable for the solidity of the structure beneath, and for the absence of calices on that surface. The granules are really spinules with expanded tops, and some are wider apart than others and taller. They arise from a stout lamina which has a very few perforations in it, and when the tops are decidedly expanded the appearance given is very scale-like, the scales being very close, but not in contact. In some places the expanded tops are clearly in contact, and a new surface has begun to be formed there. On making sections of the coral, concentric laminæ separated by radially disposed former spinules are seen around the corallites, and they reach the surfaces, which are composed of the outer lamina and the spinules upon it. The density of the coral is very striking, and there is little to denote a perforate form. The upper surface is furnished with numerous short, slender, not very proliferous ramuscules, arising from a surface where spinules surround immersed calices, and also some that are slightly prominent. The terminal corallite is rather long, stout, like all the others, without costæ, and has a rounded top of about 3 millim. in breadth, the calicular opening being very small and only measuring 1 millim. broad. The structure of this corallite is stout, made up of concentric exogenously growing laminæ and spinules, and does not exhibit the porosity of the similar corallites in the specimens already noticed. The outer surface is covered with a close array of the characteristic spinules, and it is only in very rare spots that a narrow opening occurs. Secondary corallites arise around the axial one, have the same shape, and often the calicular part is minute and subnariform. Small buds are rarely seen, but it is evident that they arise from the outer part of the parent by a growth of several spinules in a definite direction, by their arching upwards and inwards, and meeting so as to form a hood closed behind.

The texture of the hood is very close, the openings in it are extremely small, and the spinules on the parent corallite, which were within the boundary of the hood-forming ones, are still visible, and remain so until after the septa have appeared on the opposite side of the inner part of the young corallite. The usual exogenous growth produces a slight nariform swelling on the end of the bud. One minute bud may be seen behind another on the same axial corallite; but this is not a common occurrence, for the solidity of the structures of the colony appears to have been the result of very slow growth, and slow growth seems to be incompatible with budding, although not with increased deposit of the calcareous element of the sclerenchyma. Exceedingly narrow tubular passages may be seen in sections or in fractures, and they lead from the cavities of corallites to the surface, where their opening is to be detected with some difficulty, as it is surrounded by the bases of spinules.

The wall of the corallites is a thick lamina, as seen in transverse sections, and is surrounded by very regularly spaced radially disposed spinules, looking as if they were sections of costæ; but these last do not exist. Two opposite primaries, separate at the calice, are seen to be often united lower down, and they are stout and singularly imperforate.

Sometimes the four other primary septa, which are small and inconspicuous in the calice, are well developed deeper down; there they may unite with the larger primaries. Any members of the second cycle are rarely seen; but still they do sometimes exist. Finally, it is remarkable that although the other species of *Madrepora* noticed in this communication have either fairly developed dissepiments, endothecal in kind, or else true tabulæ, this last-mentioned form has neither of these internal structures.

XXVI.—*Contributions to a Knowledge of Malayan Entomology.* Part III. By W. L. Distant.

The present short paper is again devoted wholly to Rhopalocera, and is descriptive of some new species contained in a collection made by Herr Künstler in Perak, and now belonging to the Calcutta Museum. For an opportunity of examining this collection I am much indebted to the authorities of that museum, who, acting on the initiative of my friend Mr. Lionel de Nicéville, most considerately forwarded a complete set of specimens to London to aid me in rendering my 'Rhopalocera Malayana' as comprehensive as existing materials will allow it to be made in that direction. It is by such help (and I have received much unexpected and valuable assistance from other quarters) that faunistic publications can be encouraged and that the maximum of such work may be completed by a proper division of labour.

The species here described will be all subsequently figured.

Rhopalocera.

Fam. **Nymphalidæ.**

Subfam. *Nymphalinæ.*

Chersonesia peraka, n. sp.

Allied to *C. rahria*, Moore, but smaller, the ground-colour more ochraceous and less rufous; markings similar, but with the transverse fasciæ broader, much darker, and placed closer together. The obsolete caudate prolongations in *C. rahria* near the apices of the first and third median nervules are scarcely visible in *C. peraka*, and a structural peculiarity exists in the first subcostal nervule of the anterior wings, which, in the species I here describe, impinges near its base on the costal nervure.

Exp. wings, ♂ 28 millim., ♀ 34 millim.

Hab. Perak (*Künstler*, Calcutta Mus.).

Tanaëcia Nicevillei, n. sp.

Male. Wings above very dark brownish, with a violaceous tinge; anterior wings with the cell crossed by two basal black lines, continued beneath to the median nervure, two black lines near middle of cell, the innermost of which has a parallel line between the lower median nervule and the submedian nervure, and a single black line at end of cell; a small bluish spot near apex and a marginal bluish fascia commencing about centre of wing and gradually widening to outer angle, where it possesses two inner lanceolate black spots margined with bluish beneath the lower median nervule, and an inner black streak at inner margin: posterior wings with a very broad outer marginal bluish fascia, narrowest at apex of wing, inwardly margined with small blackish spots, and containing a central series of blackish spots placed between the nervules, which become practically obsolete at the area of the median nervules; three obscure blackish lines crossing cell, two near centre, and one at apex; abdominal margin brownish ochraceous. Wings beneath pale brownish ochraceous: anterior wings with the black linear markings as above, followed by a transverse series of five broad fuscous streaks placed between the nervules, those at end of cell largest; a pale violaceous marginal fascia with an inner series of lanceolate blackish spots: posterior wings with the broader outer bluish fascia as above, but paler and more violaceous, its central spots smaller, but more continuous and distinct, the three dark lines crossing cell as above, a looped line beneath the costal nervure, and an outer cellular series of three dark spots separated by the lower subcostal and discoidal nervules. Body above and beneath, with legs, more or less concolorous with wings.

Exp. wings, ♂ 57 millim.

Hab. Perak (*Künstler*, Calcutta Mus.).

This interesting species of *Tanaëcia* belongs to the section of the genus which includes *T. flora*, Butl., and, like it, has the coloration and appearance of an Euthalid above.

Fam. **Lycænidæ.**

Loxura cassiopeia, n. sp.

Male. Wings above dark reddish ochraceous; anterior wings with the costal margin (as far as subcostal nervure) and the outer margin (broadest at apex) fuscous or black, the base tinged with olivaceous brown; posterior wings with the outer margin fuscous (darkest at apex), the fringe ochraceous, the base and abdominal area more or less olivaceous brown, the tail-like appendage ochraceous with an obscure central reddish line, and the apex whitish. Wings beneath bright ochraceous, with the following brownish spots:—anterior wings with one about centre of cell, three discocellular and contiguous at end of cell, and beyond these are two separated by the second subcostal nervule; a waved macular discal band and a submarginal series of very small and somewhat obsolete spots: posterior wings with some obscure basal spots, a macular band crossing disk, but not extending below third median nervule, and a submarginal series of small obscure spots as on anterior wing. Body above fuscous, beneath greyish; legs and palpi blackish, speckled with greyish.

Female. Resembling the male, but with the posterior wings above shaded with fuscous, which is darkest on costal and outer margins.

Exp. wings 34 to 35 millim.

Hab. Perak (*Künstler*, Calcutta Mus.).

This species is allied to the *L. prabha*, Moore, from the Andamans.

Panchala trogon, n. sp.

Male. Wings above bright metallic emerald-green; nervures and nervules, extreme margins of the anterior wings, costal area, abdominal area, and posterior margin—narrowing from apex to upper median nervule and then broadly to anal angle—of posterior wings dark chocolate-brown; fringe and short tail-like appendage of the same colour, the latter with its apex greyish. Wings beneath purplish brown, the lower half of anterior wings almost without the purplish reflections: anterior wings crossed by the following greyish lines:—two looped and macular crossing cell, two discocellular at end of cell (the innermost continued to third median nervule), two discal, waved and fractured, commencing near costa and terminating at third median nervule, and two submarginal, which are narrow and somewhat obsolete; from base of third median nervule to inner margin is a narrow greyish line, from which to outer angle the colour is greyish and before which is a small greyish spot: posterior wings darker purplish, the basal area beneath the median nervure clothed with long brownish hairs and with the following greyish lines:—four macular, arranged in transverse basal series, followed by three macular, situate one above and one within cell, and one irregular in shape beneath cell; these are followed by about four, much waved and fractured, crossing disk of wing, and a waved marginal line from apex to second median nervule, where there are three blackish spots, much covered with metallic greenish scales and outwardly bordered with greyish, extending to anal angle. Body above brownish; body beneath and legs somewhat paler.

Exp. wings, ♂ 36 millim.

Hab. Perak (*Künstler*, Calcutta Mus.).

This species is allied to both the *P. eumolophus*, Cram., and the *P. aurea*, Hewits., by the metallic emerald colour above; it is, however, very distinct from both, not only by the different markings beneath, but also by the much smaller brownish markings on the upper surface of the wings.

Panchala morphina, n. sp.

Male. Wings above dark shining purplish blue, the margins (narrowly), nervures, and nervules more or less blackish; abdominal area of the posterior wings fuscous. Wings beneath pale brownish: anterior wings with the basal area from costa to median nervure, and extending outwardly to a little beyond cell, darker brown, followed by a waved fascia of the same colour, terminating beneath second median nervule, where it is narrowest; the outer margin also darker brown, with the apex and extreme margin pale violaceous. Posterior wings with the basal fourth dark chocolate-brown, with a narrow outer violaceous margin; a small chocolate-brown spot margined with violaceous above the submedian nervure, a narrow waved central violet-margined fascia crossing disk, strongly fractured at end of cell, and then more narrowly continued to internal nervure; this is followed by a short and somewhat broken fascia, commencing at lower subcostal nervule and narrowly terminating at lower median nervule, the whole outer margin broadly infuscated, the apex and extreme margin pale violaceous. Body and legs more or less concolorous with wings.

Exp. wings, ♂ 51 millim.

Hab. Perak (*Künstler*, Calcutta Mus.).

This beautiful species, of which I have only seen two male specimens, belongs to the *Apidanus* section of the genus.

XXVII.—*On the Rate of Development of the Common Shore-Crab* (Carcinus mænas). By George Brook, F.L.S.

[Plate VII.]

For over two years now I have been carrying on a series of experiments in my aquarium, with the object of throwing some light on the rate of development of *Carcinus mænas*. For this purpose from twenty to thirty specimens have been kept and isolated, and every cast shell has been carefully preserved and labelled. I should have liked, if possible, to have traced this development from the newly hatched Zoëa, but although I have had thousands of Zoëæ hatched in confinement I never yet succeeded in rearing any past the second or third moult. In August last, however, I collected a few of the Megalopa stage of *Carcinus* at Redcar, which at the next moult assumed the ordinary adult form of the Brachyuran. As soon as this stage was reached there was no difficulty in feeding them; and I am now able to combine twelve months' observations on this gathering with the material I had obtained from other specimens.

Mr. C. Spence Bate, in his paper on the "Development of Decapod Crustacea" (Phil. Trans. 1858), gives a full account of the changes gone through by the young *Carcinus* from leaving the egg to assuming the adult form. He says (p. 597):—"Having pursued the course of development from the larva to the mature form of the Brachyuran decapod

. . . . . we perceive that the progress made is not by any sudden metamorphosis, but by a series of moultings similar to those which take place in the adult; and that with each successive moult there is a corresponding degree of progress in its development. But the amount of change at each moult is so little, that it gives to the animal but a very small degree of difference in its general appearance; and it is only by a comparison of the earliest form with the last, and that without any consideration of the intermediate stages in its growth, that the idea of a true metamorphosis in Decapod Crustacea has existed. There are six or seven well-marked stages or forms that the growing animal passes through in its progress to maturity, and each of these is linked to the preceding as well as to that which follows, by a succession of changes that are but just appreciable." And again (p. 596), "Successive moults rob the young animal soon of the frontal spine. Contemporary with its decreasing importance, the *pleon* becomes gradually folded nearer and nearer, until it is closely compressed against the inferior surface of the *pereion*."

This appears perfectly true of the development of the *Zoëa* into the *Megalopa*, and up to a certain point the *Megalopa* approaches nearer and nearer the adult form with each moult. The last stage which can be called a *Megalopa* is shown in fig. 1. Here the frontal spine is very much reduced in size, and the dorsal one has disappeared altogether. The *pleon* is very much reduced also, and in its natural position is sickle-shaped, showing that ultimately it will be curled under the *pereion*. There is also a ridge forming on each side of the carapace, which is to be pushed forward and form the lateral toothed margin of the adult. The next moult is, however, a comparatively sudden change to the true Brachyuran form. The frontal spine is lost, the pleon is now curved under the pereion, and the ridge which was seen in the hepatic region of the carapace now forms the lateral toothed margin (fig. 2). All the development up to this stage has been gradual and preparatory, but now the last traces of larval form are thrown off all at once, and, generally speaking, it may be said that afterwards the animal only grows larger. Of course the carapace is not yet of the shape it will ultimately have; but what I wish to enforce is, that at this particular moult the larval characters are lost and the adult ones assumed.

Dr. Brooks in his 'Invertebrate Zoology,' gives in figs. 110 and 117 drawings of the Megalopa of *Callinectes hastatus*, and of the young crab which hatches from it. These figures agree in every respect with what has been here stated as to *Carcinus mænas*.

In Mr. Spence Bates's figure of the pleopoda of the Megalopa the last pair are not drawn correctly, unless the specimens I observed were abnormal. The pleopoda usually consist of two joints, the basal one of which has a protuberance on the inner margin, while a large number of fine bristles arise from the apical portion of the long spathulate terminal joint; but the last pair consists of two short thick joints, with only five strong bristles arising from the terminal joint (see fig. 1 *a*). Thus even in the Brachyuran larva there is an indication of the fan-like plates into which these appendages are developed in the Macrura.

The *Megalopa*-stage from Redcar was collected on the 25th of August, 1883, and below I give a list of the moults already gone through for two individuals. I had five altogether, and four out of the five followed the moults of A within a day or two so long as they lived; while B, which seemed somewhat a retarded specimen in its earlier moults, is now a fine young crab with a carapace 12·4 millim. long and 15·5 millim. broad.

	A.	B.
Ecdysis to adult form	26. $\frac{\text{VIII.}}{83}$	28. $\frac{\text{VIII.}}{83}$
1st ecdysis	5. $\frac{\text{IX.}}{83}$	15. $\frac{\text{IX.}}{83}$
2nd "	20. $\frac{\text{IX.}}{83}$	11. $\frac{\text{X.}}{83}$
3rd "	16. $\frac{\text{X.}}{83}$	1. $\frac{\text{XI.}}{83}$
4th "	14. $\frac{\text{XII.}}{83}$	29. $\frac{\text{I.}}{84}$
5th "	8. $\frac{\text{III.}}{84}$	23. $\frac{\text{IV.}}{84}$
6th "	dead.	6. $\frac{\text{VI.}}{84}$
7th "	....	9. $\frac{\text{VII.}}{84}$
8th "	....	2. $\frac{\text{VIII.}}{84}$

In the Plate will be found drawings of the Megalopa and the first six ecdyses of form B, drawn to scale, so that a careful comparison may be made of the whole series.

Fig. 2 represents the form assumed after leaving the *Megalopa*-stage. The carapace is still a little longer than broad; the rostrum continues to occupy about one fifth of the whole area of the carapace, but the frontal spine has been lost, and is now only represented by a slight undulation. This margin does not develop the three lobes, as in the adult form, until after several moults. They are first indicated by a slight depression on each side of the median line; the frontal margin after the 6th ecdysis is more undulating than in any of those preceding it, and after the 7th ecdysis the three lobes appear; but several more ecdyses have to be gone through before they obtain their normal proportions. From fig. 2 to fig. 7 the carapace assumes its normal shape by a gradual increase in its width compared to its length. With each successive moult the lateral toothed margins are pushed more forward, and the teeth become more prominent.

In the following Table I have represented the measurements of forms A and B at each ecdysis from the Megalopa onwards in millimetres, the figures above the line representing the length of the carapace and those below the width. I have then endeavoured to fit in measurements of ten other individuals which have been collected in the adult form, in in order, if possible, to form an approximate idea of the number

	A.	B.	Z.	No. 8.	P ♀.	B′ ♀.	D ♀.	C ♂	N ♂.	M ♂.	Y ♂.	*a* ♂.
Megalopa....	1·43/0·93	1·43/0·93										
Ecdysis 1 ..	1·60/1·52	1·69/1·60										
„ 2 ..	(2·1/2·3)	2·15/2·32	2·15/2·28	2·32/2·62								
„ 3 ..	2·66/3·02	2·75/3·09	2·62/2·96	2·75/3·3 4								
„ 4 ..	3·17/3·72	3·51/4·19	3·59/4·14									
„ 5 ..	3·72/4·48	(4·6/5·2)										
„ 6 ..	4·44/5·07	5·7/6·7	..	..	5/6							
„ 7 ..	..	7·5/8·9	..	..	6·5/7·5							
„ 8 ..	..	9·6/11·6	..	..	8·5/10	..	..	..	..	..	..	10/12
„ 9 ..	..	12·4/15·5	..	..	11/14	..	13/16	13/16	12·5/15·5	11/13	12/14·5	12/15
„ 10 ..	..	..	..	..	16/19·5	..	17/22	17·5/23	15/18·5	14/17·5	17/20	16/20·5
„ 11 ..	..	..	..	..	21/26·5	21/26	22/28	24/30·5	18/23	18/23	22·5/29	
„ 12 ..	..	..	..	..	..	28/35	..	..	22/29	24/31	32·5/39	
„ 13 ..	..	..	..	..	..	33/42	..	..	29/37	..	42/51	
„ 14 ..	..	..	..	..	..	..	..	..	37/45	..	45/56	

of ecdyses a specimen of any given size may have gone through. The Table may not, therefore, be scientifically accurate, but will serve my purpose. The measurements in themselves are correct; but I cannot, of course, be sure that specimen P, for example, which was 5 × 6 millim. when I got it, had already cast its shell five times from the Megalopa; but the measurements appear sufficiently near to those of A and B at that stage to warrant me in concluding that, at any rate, I am not far off the mark.

The dates corresponding with the above ecdyses are as follows:—

A and B have been already given.
Z. 19. VIII., 2. IX., and 15. IX., 82.
No. 8. 25. IV. and 28. V. 83.
P. 3. VII. 82, 29. VII., 16. VIII., 10. IX., 1. II., 83, 16. V.
B′. 2. VI. 82, 23. VII. and 25. V. 83.
D. 22. IV. 82, 10. VI., 21. VII.
C. 17. IV. 82, 8. VI., 16. VII.
N. 18. VII. 82, 17. VIII., 2. X., 5. II., 83, 21. V. and 21. VIII.
M. 12. V. 82, 12. VI., 16. VII., 17. VIII.
Y. 4. IX. 82, 5. X., 28. XI., 27. II., 83, 15. VI.
(*a*). 3. IX. 82, 7. X., 2. II., 83.

It will be seen from the above dates that out of a record of fifty-four ecdyses there is only one that occurs between the end of October and the beginning of February, while the majority are in the summer months. D and C cast their shells about the same time, and increased to about the same extent at each ecdysis. Y, on the other hand, was only the same size in September which D and C had attained in May. Again, comparing N and Y, the former only increased from 15·5 millim. to 45 millim. in ten months, whereas the latter grew from 14·5 to 56 millim. in nine months, and with the same number of ecdyses.

It would appear, then, impossible to judge either the age of any particular specimen or the number of ecdyses which it has passed through from a casual observation of it on the sea-coast, and even in confinement a number of ecdyses must be passed through before any reliable information is obtained. B′, for instance, passed through two ecdyses in the summer of 1882, and then did not cast its shell again until May 1883. N & Y, on the other hand, grew considerably larger than B′ without any such break. In attempting to guess the size A and B would be two years after hatching, A may be taken as a backward form, which would perhaps follow the ecdyses of such a form as P. In that case, next June, A would measure about 28 millim. long by 35 millim. broad. If B, on the other hand, which is a strong forward specimen, should increase to the size of Y by September, it might then be 45 millim. by 56 millim. by next June. It is also probable that in confinement the young *Carcini* do not develop exactly with the same rapidity as they would in their natural haunts. Doubtless the environment, the temperature, and possibly also the quantity of water and the amount and nature of the food available will all have their influence on the rapidity of growth.

PROCEEDINGS OF LEARNED SOCIETIES.

DUBLIN MICROSCOPICAL CLUB.

October 18, 1883.

Campanularia verticillata.—Prof. Macintosh exhibited a specimen of *Campanularia verticillata* differing from the type of the species in that the calicles have even rims instead of denticulate ones. The specimen was dredged in about 12 fathoms water off Greystones.

Sections of Chiton.—Prof. Haddon exhibited transverse sections of *Chiton* (*Trachydermon*) *ruber*, showing the presence of an oviduct, contrary to W. H. Dall's statement, the so-called "ovarian fenestræ" being merely the folded lips of the external openings of the oviducts.

Spore-bearing Nostoc.—Prof. M'Nab exhibited a portion of an unidentified *Nostoc* (which had presented itself in one of the conservatories at Glasnevin Botanic Gardens) in a fertile condition, that is to say, showing spores; these occurred in chains of several in a continuous row, elliptic and notably wider than the ordinary joints of the filaments, and seemingly showed no very noticeable relative distribution as regards the heterocysts. This is the second fertile *Nostoc* which has been noticed in this country, though several species have been found in that condition by Dr. Bornet, who has been so successfully studying the group.

Characters of the Hairs of Acanthus spinosus.—Mr. Greenwood Pim showed hairs from the anthers of *Acanthus spinosus*. These were of two kinds—one short and straight, forming a thick close brush along the edges of the suture of the anthers; the other longer and more flexuous, and situated on the dorsal portion of the anthers. The short straight hairs had their surfaces curiously reticulated into labyrinthiform folds of every conceivable shape, whilst the dorsal hairs were only longitudinally striate. The position of the latter differed according as they were growing on one of the posterior pairs of stamens, whose anthers are in apposition, or on the anterior pair, which are free throughout.

A Phycochromaceous Alga endowed with Motile Powers, seemingly not hitherto noticed.—Mr. Archer drew attention to what seemed yet another "unicellular phycochromaceous alga" (yet the cells often grouped), endowed with the power of automatic movement hither and thither. This did not seem to be at all the same as Lankester's (so-called) *Bacterium rubescens*, in which the cells are elongate and biscuit-shaped and bicoloured; here the cells were not elongate, were often bluntly angular, and when in the dividing state sometimes showed what might be called a "sub-*Cosmarium*-like" figure. Their action during progression was, however, comparatively feeble and vacillating, consisting of a trembling, irregularly rolling motion backwards and forwards, not a straight-ahead progress even for short distances. Just as in the similar cases of an active movement evinced by phycochromaceous cells, not any visible means was evident, that is to say, no cilia. However, as those skilled in the use of very high powers have demonstrated flagella on *Bacteria*, so most probably they are present in such cases as that now exhibited.

Cell-structure of Callithamnion and Laurencia.—Dr. E. Perceval Wright showed specimens of the cell-structure of species of *Callithamnion* and *Laurencia*, exhibiting the continuation of the cell-walls from cell to cell, which, in a living condition, allowed of the continuity of the protoplasmic contents, which he now regarded as characteristic of the Florideæ.

November 15, 1883.

Cosmarium striolatum, Näg., *ex herb. Reinsch, but seemingly a distinct species therefrom.*—Mr. Archer showed a preparation of Prof. Reinsch's containing an example of a *Cosmarium* labelled by him *Cosmarium striolatum*, Näg. This Mr. Archer thought it could not be, as Nägeli describes and figures his form as granulate, whereas the present noble form is quite distinctly just the reverse, that is to say, covered with deep hemispherical depressions (not granules) arranged in lines in such fashion that six depressions occur hexagonally and equally disposed around each single depression, taken as an individual. Thus the form does not assume that quasi-striolate appearance from which Nägeli drew his name. Prof. Reinsch's form now shown agrees no doubt fairly well in general outline with Nägeli's *Cosm. striolatum* (not yet found in this country); but Mr. Archer thought it must really be accounted a new and quite distinct species.

New Fungus from a Silo exhibited.—Mr. Pim showed a remarkable fungus from a newly-opened Silo at the Albert Institution, Glasnevin, where it tinged the affected part of the grass (ensilage) a deep red colour. This presented a densely-branched septate mycelium, on which were borne a large number of spherical sporangia, much resembling *Pythium* or *Saprolegnia*, yet having a very different aspect from those forms. The sporangia, which were sometimes nearly sessile and at other times variously pedicellate, were filled with broadly ovate spores. Besides these sporangia a second form of fruit appeared as small obovate bodies borne on pedicles, from which they were readily detached. These had a strong cell-wall, and occasionally contained a granule, which passed out into the water and then moved for a time. In one or two instances these had given off hyphæ, seemingly from the end where they had been attached. Mr. Berkeley and Mr. W. G. Smith appear to consider this as undescribed. Pending further investigation Mr. Pim suggests that the form be named *Fœnaria sanguinea.*

Section of the Fasciated Stem of Pisum sativum.—Prof. M'Nab exhibited sections of a fasciated stem of the common pea (*Pisum sativum*). The apical growth had become arrested and a circular wall, suggesting the so-called calyx-tube of a perigynous flower, had been formed, on the outer side of which leaves and flowers were developed. In the centre was a hollow tube, tapering below to a point and opening above, while still higher up one side of the tube had split and the stem formed a flat fasciated structure. The stem was much enlarged, and when flattened developed leaves &c. only on the outer side. A section of the stem low down exhibited two sets of fibro-vascular bundles with reversed orientation, the bast of the inner bundles being feebly developed and turned towards the epidermis, with stomata lining the interior of the tube. The double series of separate bundles might be considered as being formed by the bending over of the primary bundle when the arrest of growth of the apex took place, and by the growth of the ring-like structure by intercalar growth; the outer series were thus developed from behind upwards, while the inner series developed from above downwards, but really from the arrested normal apex upwards to the new adventitious apex. The condition was a very peculiar one and differed from any described form of fasciation known to Dr. M'Nab.

Structure of Epidermis of Curculigo latifolia, Dryand.—Prof. M'Nab likewise showed specimens of the fibre-yielding *Curculigo latifolia*, Dryand., from Borneo, noticed by Mr. Dyer in 'Journal of Botany,' vol. ix. 1880, p. 219, as being used for making clothing. The substance consisted of a thin epidermis with stomata, and firmly attached to the epidermis were numerous strong subepidermal fibres belonging to Sachs's ground-system of tissues.

December 20, 1883.

Consecutive Transverse Sections of Alcyonium digitatum.—Prof. Haddon showed a slide containing six dozen consecutive transverse sections of a polyp of *Alcyonium digitatum*, serving as an illustration of the new method of mounting on a film of shellac.

Tetraspores of Cliftonia.—Prof. E. Perceval Wright exhibited specimens of *Cliftonia pectinata*, H., showing tetraspores, and a sketch in illustration.

Seedling Nepenthes.—Prof. M'Nab exhibited a young seedling *Nepenthes* grown in the Royal Botanic Garden, Edinburgh, and given him by Mr. Lindsay. The root was long and unbranched. The pair of cotyledons was distinctly visible, and, in addition, the plant bore four small leaves, each transformed into a pitcher with simple lid. The cotyledons produced numerous longish woolly hairs. In the pitchers the glands were visible, being much developed in the third and fourth leaf, merely indicated in the first and second. A very marked feature in the structure was the presence of wide spiral tracheæ in the pitcher and its wings and also in the cotyledons. In the fourth pitcher the remains of a small apterous insect were observable. In another minute pitcher, $\frac{1}{8}$ inch long, from another seedling, the remains of a small red spider were visible. At the side of the pitcher the spiral trachides were well developed in the wings, and apparently ended close to stomata, probably water-stomata, on the upper margin. In the body of the pitcher the spiral trachides sometimes ended in close proximity to the gland. In another pitcher, about $\frac{1}{4}$ inch long, the hairs on the margin of the lid were distinctly glandular. These frequently exhibited a central spiral, and in one case, when the "tentacle," suggesting that of a *Drosera*, had been broken across, the uncoiled spiral was shown. Many minute brown hairs were scattered over the whole external surface.

Gonium tretras exhibited.—Mr. Archer showed in a living condition the form named *Gonium tetras*, distinguished from *G. pectorale*, much more common, by its having but four, not sixteen cells, in each cœnobium, and by these being more elongate towards the aspect whence issue the flagella.

Section of Foot of fœtal Ox.—Prof. D. J. Cunningham exhibited a transverse section through the middle third of the foot of a fœtal ox, which illustrated the muscular origin of the suspensory ligament of the fetlock and the particular factors which enter into its formation.

Chætocladium Brefeldi exhibited.—Mr. Greenwood Pim showed *Chætocladium Brefeldi*, a remarkable mould which occurred in considerable abundance on a small flower-pot. The fertile hypha usually branches into three principal divisions, each terminating in a long spine, whence the name, but at each side giving rise to dichotomous branches, on which are borne bodies which formerly were considered to be conidiospores (the form being referred to *Botrytis*), but, according to Van Tieghem and Le Monnier, they are one-spored sporangia. There seems to be some doubt on the point, as Brefeld, at least some years ago, does not seem to have seen the extrusion of the spore.

February 21, 1884.

Micrasterias brachyptera, Lundell, *collected in Westmoreland by*

Mr. Bisset, and new to Great Britain, exhibited.—Mr. Archer exhibited a slide from Mr. Bisset of Banchory, Aberdeen, having two specimens of *Microsterias brachyptera*, Lundell, from near Ambleside, in Westmoreland—the first time this striking and very distinct species has been found in Great Britain. It was probably somewhat curious to note the occurrence of this well-marked rarity amongst a number of quite common-place and familiar forms that might readily enough occur in any casual gathering in many places.

Algal Form developing in Solutions of Sulphate of Magnesia and of Lime.—Prof. E. Perceval Wright exhibited a minute phycochromaceous algal form, for the examination of which he was indebted to his colleague, Dr. Reynolds, Professor of Chemistry, who told him that for some time past the test solutions of sulphate of magnesia and of lime and of phosphate of soda had, in certain lights, presented quite a green shade. These solutions, it may be noted, were kept exposed to light and were prepared with all due care. The algal form abounded in all, but in the phosphate of soda it developed much more rapidly, so as to present, on the solution being shaken up, a dense flocculent cloud. The form seemed allied to *Chroococcus* and was immensely active in its cell-division and cell-growth.

Crystals formed in Stamen-hairs of Justicia speciosa.—Mr. Greenwood Pim exhibited crystals formed from the colouring-matter of the stamen-hairs of *Justicia speciosa*. These, which formed rapidly when the specimen was mounted in dilute glycerine jelly, presented the appearance of minute slender prisms of deep purple, all the colour being concentrated in the crystals, leaving the rest of the hair colourless. They also occur, but much less abundantly, in the petals.

Structure of Leaves of Selaginella stenophylla (A. Braun).—Dr. M'Nab exhibited the leaves of *Selaginella stenophylla* (A. Braun). Usually the parenchyma of the leaf of *Selaginella* is very uniform in character; but in this species there occur a number of elongated thickened cells or fibres scattered in the parenchyma, and at once recalling similar cells developed in the leaves of Cycads and Conifers. Up to the present Dr. M'Nab has not observed these cells in any other species of *Selaginella*.

Auditory Ossicles of Loach exhibited.—Prof. Haddon exhibited preparations of the auditory ossicles of the common loach.

Krakatoa Sand and its Constituents.—Dr. Frazer showed specimens of "Krakatoa Sand," being some of the ashes, which he obtained through the kindness of Mr. J. Joly, which fell on the deck of a Norwegian barque, 'The Borjöld.' Captain Amundsen's graphic account of the terrible earthquake at Krakatoa was laid by Dr. Haughton before a recent meeting of the Royal Dublin Society. The ashes yielded Dr. Frazer an abundance of magnetic iron, easily isolated by the action of a steel magnet. The pumice, of which the mass of the ashes consisted, displayed under the microscope delicate threads like the well-known "Pelé's Hair," and there could be recognized marked crystals of a triclinic felspar, a monoclinic crystalline substance, augitic pyroxyene, also a rhombic mineral, probably a hypersthene. These minerals, so far as Dr. Frazer knew, were quite distinctive of this "Sand," for he had not observed any similar combination in any pumice which he had examined. Mr. Joly had also investigated this dust and had given a full communication on the subject to the Royal Dublin Society, illustrated with photographs. He found small crystals of iron pyrites and of a mineral, probably bornite; these were not noticed by Dr. Frazer. From an attentive consideration of the microscopical appearances Dr. Frazer was disposed to conjecture that steam alone was not the eruptive agent; but probably at a high temperature the steam was resolved into its gaseous elements, thus accounting for the violence of the explosion which took place and for the quantities of minute porosities visible in the pumice, which in parts recalled to mind the appearance of viscous ice, whence particles of imbedded air are gradually escaping.

March 20, 1884.

Section of Diorite from Loch Assynt.—Prof. Hull exhibited a section of a peculiar sheet of diorite of intrusive origin found in the limestone of Loch Assynt in the form of a sheet or dyke. Under a low magnifying-power it is seen to be a beautifully crystalline rock consisting of crystals of hornblende, triclinic felspar, and magnetite imbedded in a glassy paste. The polarization of the minerals was vivid, and in the case of the pyroxenic mineral indicative of hornblende rather than of augite.

Structure of Leaves of Selaginella densa.—Dr. M'Nab exhibited preparations of an undetermined species of *Selaginella* which was cultivated by Mr. Sim of Foot's Cray, Kent, as *Selaginella densa.* On examination it was observed that stomata were developed along the margins of the leaves as well as in the usual position near the mid-rib. A similar arrangement of marginal stomata occurs in cultivated specimens of *Selaginella Poulteri.*

Section of a clastic Rock from Bray Head exhibited.—Prof. V. Ball exhibited a section of a dense purple-coloured rock which is found near the southern extremity of the section of Cambrian rocks forming Bray Head. The mode of occurrence of this rock being for the most part obscure, although at one point it is distinctly stratified, this, together with its density and hardness, made it desirable to examine its microscopical characters. It proves to be a distinctly clastic rock, consisting mainly of small fragments of quartz in a ferruginous matrix. It may be regarded as a somewhat exceptional variety of the group of rocks of this age to which the term "grit" used to be applied by Prof. Jukes.

Zygospores of Euastrum elegans and E. pectinatum exhibited for comparison and contrast.—Mr. Archer drew attention to examples of the zygospores of two sufficiently common species of *Euastrum*, viz. *Euastrum elegans* and *E. pectinatum*. These zygospores, of course, have a strong family resemblance, not only to each other, but to other species of *Euastrum*, yet their differences of appearance, or *tout-ensemble*, were readily discernible. The zygospores in the genus are globular, and beset by usually not very numerous, often rather elongate, very slightly tapering, bluntly ending, semi-pellucid "finger-like" spines. In the *E.-elegans* zygospore they are more elongate, more curved, less numerous than in that of *E. pectinatum*, where they are thickly studded, short and straight; hence the latter makes a prettier object.

Sections of Halisarca lobularis.—Prof. Sollas exhibited a series of sections of *Halisarca lobularis*, from Roskoff, Brittany, showing the various stages of development of the young embryo within the matrical tissue.

Characters of Stamen-hairs of Narthecium ossifragum.—Mr. Greenwood Pim showed hairs from the stamen of *Narthecium ossifragum*. These hairs, which clothe the stamens very densely, are pluricellular, consisting of oblong cells, each of which shows spiral striations, and contain numerous large globules, apparently of oil, and which when fresh are of a yellow colour.

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An Elementary Course of Botany, Structural, Physiological, and Systematic. By the late Professor ARTHUR HENFREY, F.R.S., F.L.S., &c. Fourth Edition. By MAXWELL T. MASTERS, M.D., F.R.S., F.L.S., assisted by A. W. BENNETT, M.A., B.Sc., F.L.S. Van Voorst, 1884.

IF King Solomon had been pursuing his botanical studies, "from the Cedar of Lebanon to the hyssop that springeth out of the wall," in England at the present day, he would probably, in stating that "of the making of many books there is no end," have made special reference to the text-books of his favourite science. Out of some few good, some bad, and many indifferent text-books of botany, Dr. Masters and Mr. Bennett are to be congratulated upon having edited, and Mr. Van Voorst upon publishing, the most complete work of the kind, which represents the recent progress of the science, in our own or perhaps in any language. What faults we have to find will not, as a rule, be in matters of fact or of omission; but mainly in questions of inclusion and arrangement. The present is the fourth edition of a work that originally appeared in 1857, the second bearing date 1870, and the third 1878. There are more than twenty excellent new woodcuts, and, besides minor alterations, the sections dealing with Algæ, Protophyta, and the reproduction of Phanerogamia have been almost entirely rewritten by Mr. Bennett; but "the general plan of the work has not been materially altered," and it is on this point that we mainly complain. In his original preface Professor Henfrey made the following remarks:—

"The largest class of students of Botany are those who pursue the subject as one included in the prescribed course of medical education. One short course of lectures is devoted to this science, and three months is commonly all the time allotted to the teacher for laying the foundations and building the superstructure of a knowledge of Botany in the minds of his pupils; very few of whom come prepared even with the most rudimentary acquaintance with the science. . . . . . If the previous education of medical students prepared them as it should with an elementary knowledge of the Natural Sciences we should make Physiology the most conspicuous feature of a course of Botany in a medical school." At the present day, while admitting with Professor Huxley that Botany might well be excluded from the medical curriculum, it may be urged that students entering upon that curriculum should furnish proof of attainments up to the standard of the Preliminary Scientific Examination of the University of London; and that, after studying some first book of Botany, "Physiology," which to Professor Henfrey included Histology, might well be the "most conspicuous feature" in their training. In the present work "Physiology" forms the subject of Part III., occupying but 200 pages out of a total of nearly 700, and in it are included both Embryology and Histology, the latter under the meaningless name "Physiological Anatomy." Systematic Botany (Part II.), on the other hand, occupies nearly 300 pages, only 170 of which are devoted to the multiform Cryptogamia, whilst the inclusion of such Natural Orders as Dilleniaceæ, Schizandraceæ, Lardizabalaceæ, Cabombaceæ, Sauvagesiaceæ, and such like, in a work which is not complete as a 'Genera Plantarum,' evinces a want of discrimination between a text-book and a book of reference. Surely it would have been better to have made the present work exclusively the former, *i. e.* a work whose contents the student may hope one day to carry in his head, leaving the other function to such books as Bentham and Hooker's, or LeMaout and Decaisne's.

The only other regret of a general character that this edition suggests is the absence of bibliographical references. Controverted points are perhaps best omitted from a text-book, and a fact is undoubtedly of infinitely greater importance than the authority for it, whether ancient or recent. The plan adopted seems to have been to name recent writers only: but surely references to their chief papers, in which more detailed information can be found, would be far more valuable and need not occupy much space.

The new terminology for the Cryptogamia, proposed by Messrs. Bennett and Murray, is adopted in the latter part of the work, but not consistently used throughout, "oospore" occurring on p. 10;

and similarly, on p. 325, the *nucellus* of the ovule is alluded to as the "nucleus." The renumbering of the figures has not always been attended to; thus on p. 16 "fig. 16" should be "fig. 27," and on p. 19, figs. 22 and 19 should be 13 and 11 respectively; nor is the Index free from slips, the terms "fastigiate" and "caryopsis" both occurring in it, though unaccountably omitted in the text.

The account of the various methods of branching is the best we remember to have seen, though we feel inclined to demur to the statement (p. 83) that "the difference between a dichotomy of the growing-point and lateral ramification is not fundamental," and to prefer the terms 'Racemose,' 'Pleiochasial,' and 'Unilateral,' to 'Botryose,' 'Dichasial,' and 'Sympodial' respectively; for surely the Dichasium is made up of many 'podia' equally with the 'cicinnus' and 'bostryx,' though no pseud-axis be apparent.

It might have been well in classifying the venation of leaves to bring out more prominently the importance of this character in the major groups of the higher plants; but against this omission we may set off the very useful description (on p. 74) of the bracteoles in Dicotyledons and Monocotyledons. Though we do not attach much importance to terms, perhaps 'orthostichy' and 'parastichy' might have been conveniently introduced, whilst 'opposite' seems a less confusing term than 'intrapetiolar' for such stipules as those of *Astragalus*, seeing that 'interpetiolar' is also in use, in the case of *Galium*, &c.; nor can we see why, if 'monœcious' is correct, 'heteroicism' should be so spelt.

In the portions of Part II. relating to the Principles and Systems of Classification much matter mainly of historical interest has been omitted, as is also the table of Natural Orders in the 'Contents' of previous editions.

The arrangement adopted wisely follows Bentham and Hooker so far as flowering plants are concerned, and removes the Gymnosperms from their false position between Dicotyledons and Monocotyledons. It retains the great artificial group 'Cryptogamia,' and the convenient, though physiological classes 'Algæ' and 'Fungi,' and—as we think, very wisely—divides the vascular Cryptogams into *Heterosporia* and *Isosporia* (a point upon which Sachs seems doubtful), makes the *Charales* of equivalent rank with the *Muscineæ*, and the *Myxomycetes* on a level with *Zygomycetes*. The use of the term *Cormophyta* as an equivalent for *Acrogens*, and not in the sense originally intended by Endlicher, is a pity; and there does not seem any sufficient reason for making the Protophyta into a class coordinate with Algæ and Fungi, seeing that the only valid distinction between the two latter groups—namely the physiological test of the presence or absence of chlorophyll—is equally obvious as between *Protophyceæ* and *Protomyces*.

The account of the Natural Orders of Phanerogams is enriched with floral formulæ from Eichler and numerous notes on fertilization from Hermann Müller, and on floral development from Payer, besides many passages which show that this part, like the preceding one, has been carefully brought down to date. Such are, for instance, the references to Professor Balfour's description of *Halophila* and of the wild form of *Punica*, and to Mr. Bower's account of the germination of *Welwitschia*; *Gynocardia*, the source of Chaulmagra Oil, cannot, however, be rightly referred both to the *Dilleniaceæ* and *Pangiaceæ*, nor can the Bladder-nut (*Staphylea pinnata*) be truly termed a native; whilst we must confess ourselves unable to understand Professor Gray's suggestion "that we need not consider the ovule of *Taxus* to be an axial structure simply because it is terminal, it may be a leaf 'suppressed to the utmost'." Surely a leaf cannot be truly terminal!

In the Cryptogamic portion an account of "apogamy," of the Lycopodia, of some structural details in *Sphagnum*, and of the vegetative structures of *Characeæ* are important additions; but we should like to have had more precise information as to the "remarkable and complicated structure" of the stomata in *Marchantia*. The account of the Protophyta is excellent, and much relating to the Fungi is new, as is most of the account of the Algæ. The statement that "the compound nature of Lichens has been completely established" is a stronger expression than we have seen in any English publication, but is certainly the opinion of the younger school of botanists. The logical consequence of this view would seem to be the dispersal of the group among the *Discomycetes* and *Pyrenomycetes*.

We cannot admit that among *Basidiomycetes*, "according to the most probable hypothesis, the so-called 'receptacle' is a fructification, the result of the conjugation of unknown sexual organs yet to be discovered on the mycelium," since it seems far more probable that the sexual stage has been apogamously lost.

Empusa is, by a slip, alluded to among the *Saprolegnieæ*, on p. 444.

In histology, modern researches by Strasburger on the nucleus, on the continuity of protoplasm, and by Elfving on pollen are admirably summarized, and accounts of sieve-tubes, emergences, vittæ, and other structures, passed over in the third edition, are given; whilst in the department of pure physiology more chemical detail and an account of metastasis are the chief additions. In Chapter VI. of Part III. the full account of the formation of pollen, of the embryo-sac, embryo, suspensor and endosperm, according to the newest lights, is of extreme interest.

The fourth part, devoted to Geographical and Geological Botany, is much as in former editions, allusions to Mr. Dyer's generalizations being added in the first two chapters; whilst in the third the term "Transition," long disused by geologists, is unfortunately retained: *Antholithes* is said to have "much the general appearance of an Orobanche"—a statement calculated to mislead a student into thinking that it is a case of affinity; and the Bovey Tracey lignite, which is almost certainly of Middle Eocene age, is still treated of under the head of Miocene.

These are, however, but small blemishes in a work of such wide scope and such general excellence, and we can only hope that a fifth edition may soon be reached in which they can be attended to, and that the botanical students of the next thirty years may continue to have, as we have had, their 'Henfrey' kept well up to date.

G. S. Boulger.

Second Annual Report of the United-States Geological Survey to the Secretary of the Interior, 1880–81. By J. W. Powell, Director. 4to. Pp. 588, with a large map, 61 plates of views, maps, and diagrams, and 32 woodcuts of views, sections, and diagrams. Washington: 1882.

This handsome and comprehensive volume contains:—I. The Director's Report, both *general*, on the Survey and its work, and *special*, on the research and results of each Head-Surveyor and his subordinates. II. Administrative Reports by the several Heads of Divisions. III. The Reports and Memoirs themselves, supplied by the officers and other members of the Survey.

The Director, in his Report on the "Plan of Publication" and "General Considerations," treats both of the nomenclature of the geological divisions, as proposed and used by Dana, Le Conte, and the Survey, and of a uniform system of colours proposed for geological cartography.

1. The first Report is on the Tertiary History of the Grand-Cañon District, by Captain C. E. Dutton. Of this a notice, together with the expression of the writer's high opinion of its great worth, has already appeared in the 'Philosophical Magazine,' 1884, ser. 5, vol. xvii. p. 551.

2. The History of Lake Bonneville, by Mr. G. K. Gilbert, who has arrived at the opinion that "first, the waters were low, occupying, as Great Salt Lake now does, only a limited portion of the bottom of the basin. Then they gradually rose and spread, forming an inland sea nearly equal to Lake Huron in extent, with a maximum depth of 1000 feet. Then the waters fell, and the lake not merely dwindled in size, but absolutely disappeared, leaving a plain even more desolate than the Great-Salt-Lake Desert of to-day. Then they again rose, surpassing even their former height, and eventually overflowing the basin at its northern edge, sending a tributary stream to the Columbia River. And last, there was a second recession, and the water shrank away—until now only Great Salt Lake and two smaller lakes remain." Thus, "there were two epochs of excessive moisture or else of excessive cold, separated by an interval of superlative dryness, and preceded by a climatic period comparable with the present." The first term of wetness was the longer, and the second was the more intense.

3. The Geology of the Eureka District, by Mr. Arnold Hague.

This important mining centre in Central Nevada is in the Great Basin, which consists of Palæozoic rocks (Cambrian to Carboniferous), 20,000 feet thick, extensively faulted and affected by Tertiary volcanic eruptions. A complete monograph is being prepared.

4. The Geology of Leadville, Colorado, by Mr. S. F. Emmons. The Mosquito range is rich with silver-lead ores in a Carboniferous dolomitic limestone, overlain by intrusive sheets of porphyry. They have a gangue of iron, manganese, and clay, which sometimes replaces nearly all the limestone. The whole has been uplifted, folded, faulted, and shattered, and subsequently greatly denuded. Mr. Emmons thinks that originally the metallic minerals were in the porphyries, and that percolating water took them down into the limestone, as sulphides, before the disturbances took place, dissolving the limestone away with chemical interchanges. He suggests that sulphides will be found to be more abundant lower down, but poorer in silver than near the surface.

5. The Geology of the Comstock Lode, by Mr. G. F. Becker. The high temperature in the deep sinkings of this wonderful source of silver-ore is referred by Mr. Becker, not to the kaolinization of felspar, as has been suggested, but to a source of underground heat at more than two miles from the surface. The heat has been transmitted to the side-rocks by the lode. Some gases also are present; and the evidences show "that the immediate neighbourhood of the Comstock lode must be considered as a solfatara, now almost extinct." The ore was deposited probably "by 'lateral secretion' at or near the contact between the diorite (foot-wall) and the diabase (hanging-wall)." This is offered as the basis for practical guidance in the mine, where much money has been wasted. Mr. Becker finds that the so-called "propylite" and "quartz-propylite" are merely decomposed dioritic and hornblendic rocks. Other results of rock-change, also the structural results of faulting, the electrical activity of ore-bodies, and other interesting physical investigations, are here treated succinctly, and are to be further described in a full Report on the Comstock Lode and the Washoe District.

6. The Director mentions a History of the Comstock Lode, as being in course of preparation by Mr. Eliot Lord, not only treating of the discovery and working of these mines, but of the growth of the industries resulting therefrom, and the development of Mining Law, to which these gave rise.

7. On the Production of the Precious Metals in the United States, by Mr. Clarence King. This concise and valuable *résumé* of the statistics of the bullion production in the United States for the tenth census-year, ending May 31, 1880, precedes the intended, far more elaborate, technical Report on the Distribution and Production of the Precious Metals in the United States. The basis has been 2730 reports, from 1967 deep mines, 325 placer-mines, 327 amalgamating-mills, concentration-works, and chlorination and leaching establishments, 86 smelting-works, and 25 arrastras. The output

for the year mentioned was $33,379,663 gold and $41,110,957 silver, a total of $74,490,620 (coining value). The compilation and tabulation have been made under the direction of a special expert, Mr. Albert Williams, jun. The methods followed in compilation and in the classification of mines and of reduction-works are first given. Then the statistics of the Pacific division :—California, Nevada, Utah, Arizona, Idaho, Oregon, Washington, and Alaska. Statistics of the Rocky-Mountains division :—Colorado, Dakota, Montana, New Mexico, and Wyoming. Statistics of the Eastern division. *Résumé* of reduction statistics. Coinage. Consumption in the Arts. Other estimates. Bullion-product of the World.

Colorado produces 40 per cent. of all the silver of the United States, but only 8 per cent. of the gold. California yields half of the gold, but less than 3 per cent. of the silver. The production of the precious metals in proportion to population, ranging from one mill ($0·001) per head in Alabama, to $278·14 in Nevada, shows with precision how far "mining is a factor of wealth in the several localities." The product per square mile varies from 1 cent for Alaska to $185·20 in Colorado, "the intermediate average forming another standard of developed richness in the precious metals, from a different point of view, but roughly corresponding to that of the relation of production to population." The average fineness of gold for the United States is fixed at ·876, the placers producing "over $100,000 of silver annually in alloy with the gold—an item hitherto disregarded by statisticians." Very clear, definite, and elucidative coloured diagrams illustrate the production- and distribution-tables above noticed.

8. A new method of measuring Heights by means of the Barometer, by Mr. G. K. Gilbert. This is a complete memoir, resulting from the author's experience in geographical work which he was obliged to take in hand when making the necessary maps for geological surveying in unmapped territories. The new method of hypsometry is so simple and direct that it has been adopted by the United States Geological Survey. Three barometers are used instead of two ; two are placed at points where the heights are known, and the third is read at the point to be determined. "From the reading of the two barometers at the points of known height the weight of the intervening air-column is deduced ; and, both the weight and height of the column being known, its density is computable. The density thus derived is then used in the computation of the height of a second column of air contained between one of the known points and the point to be determined." In explaining this important barometrical discovery, Mr. Gilbert treats in full of the barometer and the principles on which its use is made practical ; and of modifying conditions in the relation between air-pressure and local heights, such as density, temperature, and humidity ; and of the resulting "atmospheric gradient," diurnal, annual, and non-

periodic. The influence of wind on the tension of the air in the Observatory on Mount Washington was incidentally found to affect the barometer seriously, and even to vitiate its record. Next he describes the devices for the elimination of hypsometric errors, or for diminishing them. The "new solution" is then explained in detail and compared with other methods. Possible improvements are suggested, and some circumstances under which it is not available are carefully stated.

Eight plates of very complete and distinct diagrams illustrate altitude-determinations, with their periodic and other variations; and several useful woodcuts also help to elucidate the author's views and observations.

The mass of valuable information collected in this well-illustrated volume, put together by first-class geologists, at the cost of the liberal United States Government, and freely circulated also at its expense, is welcome to geologists and others all over the world; and we cordially recognize the heartiness of work it exhibits and the liberality with which it is distributed.

MISCELLANEOUS.

On Floral Polymorphism in Narcissus reflexus. By M. L. Crié.

I have the honour to indicate to the Academy a new instance of floral polymorphism in the *Narcissus* of the Glénans (Finistère). This plant, which is very rare and little known to botanists, forms part of that *Breton* centre of vegetation that I have characterized by *Eryngium viviparum*, *Omphalodes littoralis*, and *Linaria arenaria*.

The Glénans Narcissus, of which I was able to collect some hundreds of flowering specimens towards the end of April this year, appears in the island under three forms, which are very unequal in number. The first two differ in the length of the pistil and stamens.

In one the style, which is much shorter than the six stamens, raises its stigma a little way above the constriction formed by the base of the tube of the perianth. The three stamens of the inner row are shorter than the three of the outer row; it is the brachystylate form.

In the other, the style, longer than the six stamens, raises its stigma above even the three stamens of the outer row, which are the longest and the first formed (A. Chatin). This is the dolichostylate form.

This remarkable floral polymorphism in *Narcissus reflexus* has escaped the notice of Loiseleur and other botanists, who have simply indicated in this plant the difference of length which exists between the six stamens:—"*Stamina 3 longiora et 3 alterna breviora*" (Lois. Flora Gallica).

But there also exists at the Glénans a third form much more rare than the preceding—a form with the andrœcium triandrous, in consequence of the abortion of the three stamens of the inner row. In certain dolichostylate flowers we notice that the three inner stamens, hidden at the bottom of the tube, are nearly sessile upon the perianth; in others the anthers become completely aborted and the flower becomes triandrous.

Narcissus reflexus, Lois., therefore presents, at the Glénans, three remarkable forms:—(1) a form with a long style and with shorter stamens (dolichostylate form); (2) a form with a short style and with longer stamens (brachystylate form); (3) a triandrous form, produced by the abortion of the three inner stamens. This Narcissus with a triandrous andrœcium directly connects the Amaryllideæ with the Irideæ, which are only Amaryllideæ with *three extrorse stamens.* But by its *triandrous andrœcium and its introrse stamens* the *Narcissus reflexus* still more directly unites the Amaryllideæ with the Hæmodoraceæ through certain genera which, like *Dilotris*, *Lachnanthes*, and *Phlebocarya*, possess three introrse stamens and a perfectly inferior ovary.—*Comptes Rendus*, June 30, 1884, p. 1600.

Anatomy of Epeïra. By M. Vladimir Schimkewitsch.

M. Schimkewitsch has published, in the 'Annales des Sciences Naturelles,' a most important paper, accompanied by eight plates, upon the anatomy of *Epeïra*. The conclusions resulting from his investigations he sums up as follows:—

1. It is possible to establish the homology which exists between the appendages and the various parts of the body of the Arachnida and those of the other Arthropoda (Myriopoda and Insecta, Crustacea and Limulidæ).

2. The Arachnida, placed between the Tracheata and the Limulidæ on the one hand, and the Crustacea on the other, are destitute of antennæ.

3. Their mode of development, as well as the structure of their organs of digestion, respiration, and vision, approximate them to the Myriopoda and the larvæ of insects.

4. On the contrary, by their circulatory apparatus and their muscular system, the higher Arachnida approach the Limulidæ; but this resemblance may be explained by the identity that exists in the general configuration of the body in these two forms; for the Limulidæ, according to their evolution (Nauplius-stage and Trilobite-stage), and according to the constitution of the respiratory apparatus, are true Crustacea destitute of antennæ.

5. The Scorpionidæ represent a form more ancient than the Araneidæ.

6. The Tetrapneumonous Araneidæ present more ancient forms than the Dipneumona.

7. The appendages of the Pycnogonidæ may be compared with those of the Arachnida, and the Pycnogonidæ resemble the Spiders in the structure of their generative and digestive organs.—*Annales des Sciences Naturelles, Zoologie*, sér. vi. tome xvii.

On the Physiology of a Green Planarian (Convoluta Schultzii). By M. A. Barthélémy.

Convoluta Schultzii is a singular animal, of a nature to excite the interest of those naturalists who pay attention to the function of chlorophyll. It is not one of those creatures of doubtful position and, so to speak, intermediate between the two kingdoms, but a comparatively high organism, in which the association with chlorophyll elements has produced interesting physiological peculiarities. By the extreme kindness of M. Lacaze-Duthiers I have been enabled to study this interesting creature, which lives and develops in abundance at Roscoff. Its anatomy, and especially its embryogeny, must be the subject of a special investigation ; I shall content myself in this note with speaking of its physiology.

I shall only state that this *Convoluta* presents a ciliated cuticle, a muscular layer giving origin to longitudinal bands, and a central parenchyma replacing the digestive tube. There is neither mouth nor œsophagus, and still less an anus. This construction resembles that of the Infusoria, especially of *Opalina*.

As regards the chlorophyll element, it is represented by cells with greenish-yellow contents, and presenting a nucleus which is brought into view by attacking the chlorophyll with ether and then treating with potash. These elements are free upon the surface of the central parenchyma, and when the latter escapes, in consequence of an accidental rupture, it is not uncommon to see one of these cells also escape surrounded by protoplasm. It seemed to me that these chlorophyll-cells multiplied by division of the nucleus.

I must not forget to mention the existence (which, however, is not constant) of fusiform bacilli inserted into the cuticle by a sort of nail-head, and often collected, to the number of four, at the posterior part of the animal; and, lastly, of bundles of very fine, granular, parasitic Nematodes, much attenuated at the extremity, which live and move for some time when detached from the animal; but I do not know whether it is to these that we must refer the nematocysts with protractile filaments that Gräff has described in *Stenostomum Sieboldii*.

When held between the fingers, the animal diffuses a phosphorous odour, which reminded me of that of the *Suberites* upon the beach at Banyuls.

To sum up, the *Convoluta*, by the absence of the digestive tube, the œsophagus, and even the mouth, by the activity of its ciliary movements, and by the layer of chlorophyll-cells, has the appearance of a physiological association, a symbiosis between a unicellular alga and an accelate worm.

Thanks to the presence of the chlorophyllian element, the animal can live in a medium deprived of air, in stagnant pools where life would be impossible, while, by its vibratile movements, it constantly furnishes the plant with the current of carbonic acid necessary for its nutrition, and of which, in its turn, it utilizes the oxygen originating from the chlorophyllian function.

The physiology of *Convoluta* is necessarily reduced to endosmotic exchanges, through the external cuticular layer, of liquid nutritive substances and gaseous solutions.

The act of respiration has been the subject of a full investigation made with much care by Mr. Patrick Geddes *. However, being governed by ideas which are still current in vegetable physiology, he has sought to collect and analyze the gases which *seemed* to him to be evolved from these little organisms under the action of the sun; and, further, his researches were made upon a quantity of animals so considerable (a surface of one third of a square metre covered with Planarians) that it is impossible to draw deductions from them as to the individual life of each.

The first fact that strikes the observer after placing a certain number of the *Convoluta* in a series of flasks is the tendency that they have to move towards that part of the room, or rather of the flask, which is most strongly illuminated. It is an *organic photometer* of extreme sensibility.

These worms are destitute of visual organs, even rudimentary; but if it is true that vision in the higher animals is only the result of chemical action, a decomposition of the retinic purple, we may assume that the action of the chlorophyll upon carbonic acid produces a sort of visual sensation in the animal. It is to be remarked that the ascent of the Planarian takes place slowly, and, so to speak, unconsciously, under the influence of movements of the vibratile cilia more energetic in the direction of the light. On arriving at the surface of the water our worms attach themselves by their posterior part; but at the least agitation of the water or the vessel they detach themselves and fall to the bottom with very precipitate movements.

As regards the emission of gases and the deductions that can be drawn from them to furnish evidence, or the measure, of the respiratory act, I can assert that it does not exist. We have only to avail

* Arch. Zool. Exp. tom. viii. 1879-80.

ourselves of the action of light just indicated, to attract to the most illuminated and *most elevated* point in the vessel all the Planarians, when we can convince ourselves that the fine bubbles of gas of which Mr. Geddes speaks start from the particles of sand or the organic fragments of the lower part of the vessel. On examining with the lens the green mass formed by the *Convoluta* we cannot detect any gas-bubbles. Could it be otherwise with the continual movement of the vibratile cilia, which is opposed to the *formation* of the bubbles? and in the absence of any internal cavity in which the gases could accumulate or circulate?

The giving off of oxygen in the gaseous state would presuppose a respiratory activity out of proportion to the small quantity of chlorophyll presented by our Planarians, even when collected into a great mass.

The bubbles obtained by Mr. Geddes presented from 43 to 52 per cent. of oxygen, the rest being nitrogen. It seems to me that this residue of nitrogen must not be neglected, and that it would be necessary to assume that besides the 40 per cent. of oxygen, our worm excretes 60 per cent. of nitrogen of unexplained origin. It must further be remarked that the analysis of the gases dissolved in sea-water presents great difficulties and has not yet been made in a satisfactory manner*.

In reality, no completely aquatic plant or animal evolves gases under normal and regular conditions, and the *Convoluta* forms no exception to this law.

In an excess of carbonic acid aquatic plants do not set free oxygen except when they possess air-ducts and the leaves are detached from the stalk, or when they have retained a layer of air at the surface. In presence of an abnornal quantity of carbonic acid, the *Convolutæ* produce very small granules of amylaceous matter which are deposited in the mesoderm. If the excess of carbonic acid be too great the animals are destroyed; then the association is broken up and the unicellular alga undergoes a new evolution, the course of which has still to be traced.

Thus the respiratory act in *Convoluta Schultzii* consists in the absorption through the cuticle of carbonic acid in solution, which the chlorophyll decomposes with production of oxygen. The latter is utilized by the animal in whole or in part, so that if oxygen is exhaled it can be only in very small quantity and not in the gaseous state under normal conditions. This respiration presents a striking analogy with that of submerged aquatic plants, such as we must now-a-days conceive it to be.—*Comptes Rendus*, July 28, 1884, p. 197.

* See 'Revue Scientifique,' June 21, 1884, and later.

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[FIFTH SERIES.]

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XXVIII.—*The Classificatory Position of* Hemiaster elongatus, *Duncan & Sladen: a Reply to a Criticism by Prof. Sven Lovén.* By Prof. P. Martin Duncan, F.R.S., and W. Percy Sladen, F.L.S.

We have quite lately received from Professor Sven Lovén his most interesting and valuable work entitled 'On *Pourtalesia*, a Genus of Echinoidea.' This beautifully illustrated work was read before the Swedish Academy of Sciences in June 1882, and was published in 1883.

On studying this most masterly communication, we were impressed that Prof. Lovén had hardly done himself justice in a criticism upon the zoological position which we have given to a very interesting species of *Hemiaster*. The criticisms are short and sufficiently decided; but we felt that as they came from the most exact student of the Echinoidea of the age, they demanded our most respectful and candid attention. We both studied the form of *Hemiaster* to which Prof. Lovén has given an altogether different generic position; we both agreed to the description of the species which appeared in our work on the Echinoidea of the Ranikot group of the Tertiaries of Western Sind; and we are both responsible for the correctness of the drawings on our plate xix. Fortunately the specimens of *Hemiaster elongatus*, nobis, are still in our hands, and we have again gone very carefully over them. It is only just to ourselves to state that in describing the species the more or less exact resemblance of the apical system to that of *Palæostoma* was not lost sight of; but the construction of the whole actinal area differed so decidedly from that of the genus just named, that we could not entertain the possibility of our form belonging to it.

Moreover, since the publication of the 'Echinoidea of the Ranikot Group,' we have completed and published a description of the fossil Echinoidea of the true Nummulitic rocks of the Khirthar strata of the same region, and amongst them are some forms of another *Hemiaster* (*H. digonus*, d'Archiac) with two large generative pores only, and which should equally be the subject of Prof. Lovén's criticism.

The first passage in which Prof. Lovén refers to our species is on page 73, in a footnote:—"Another stranger is *Hemiaster elongatus* of Indian Tertiaries. It is a *Palæostoma*." The second notice is on page 79, in a footnote:—"A fossil species of this genus from the Nummulitic strata of Western Sind has been described as *Hemiaster elongatus* by Duncan and Sladen, Mem. Geol. Survey India, Tert. Ser. xiv. vol. iii. p. 78, pl. xix. figs. 7–15, 1882."

We propose in this communication to reply to Prof. Lovén's statements by arranging our answer as systematically as possible:—

I. The classification of the Leskiadæ, Gray, and the details of those parts of the structures of *Palæostoma* which have a special bearing upon its generic diagnosis, with a notice of the descriptions of Gray, A. Agassiz, and Lovén.

II. A notice of Lovén's comparison of the genera *Palæostoma* and *Palæotropus*, and of its bearing upon the method of distinguishing other genera.

III. A description of *Hemiaster elongatus*, nobis, so far as the structures bear upon its generic position.

IV. A description of *Hemiaster digonus*, d'Archiac.

V. A comparison of the essential structures of *Palæostoma mirabile*, *Hemiaster elongatus*, and *H. digonus*.

VI. A brief notice of the reasons why we still place the two species from Sind in the genus *Hemiaster*.

I.

In the 'Revision of the Echini,' by A. Agassiz, p. 582, the subfamily of the Leskiadæ of Gray is introduced, in order to include the genus *Leskia*, which was afterwards named *Palæostoma* by Lovén, and it belongs to the family Spatangidæ.

Leskiadæ.—No distinct subanal or actinal plastron; a peripetalous fasciole, enclosing slightly sunken ambulacra, which are petaloid. Anal system covered by a small number of plates; actinostome *pentagonal*, covered by five converging plates, flush with the actinal surface.

Dr. Gray gave a very full diagnosis of his family (not subfamily) Leskiadæ in the Cat. Recent Echinida in the Coll. of the Brit. Mus. pt. i. p. 63, and in consequence reduced the length of the generic diagnosis in the same work. The date of the genus of Gray is 1851, and it was first published in the Ann. & Mag. Nat. Hist. 1851 (vol. vii.). The family is diagnosed as follows:—

Shell ovate, subglobose, thin; vertex central; lateral ambulacra broad, petaloid, rather sunken, and separate from each other; the hinder lateral pair rather the shortest; the odd anterior ambulacrum is in a rather broad sunken groove, rudimentary, with a single series of pores on each side, all surrounded by a broad, rather sinuous, peripetalous fasciole; lateral and subanal fasciole none; mouth anterior, *round*, on a level with the rounded under surface, and covered with five triangular converging valves; plastron and subanal plate not distinctly defined; anus round, in the upper part of the rounded posterior end, and covered with five triangular converging valves, forming a cone, with small spicula in the centre; ovarial pores two, very large; spines and tubercles subequal, subulate, those of the back being rather the largest.

As the genus *Leskia* (subsequently *Palæostoma*) was the only one of the family, Dr. Gray did not give a special generic diagnosis, but contented himself with stating that the genus has the characters of the family.

He remarks, "This genus agrees with *Brissus* in the form of the peripetalous fasciole, but differs from it and all other Spatangidæ in the form of the mouth and vent." He mentions the species *Leskia mirabilis*, and states that the test is ovate and subglobose. Dr. Gray gave two drawings of the species (Cat. Echin. Brit. Mus. &c., pl. iv. fig. 4), and the delineations carry out the idea given in the descriptions; the absence of a definite plastron, and the generally rounded form of the under part are evident; but the drawing conveys the impression that the peristome is not round, but pentagonal. The upper surface of the test presents posteriorly a shallow groove, in which is the anal opening with its plates. By way of contrast Dr. Gray placed a figure of the under surface of *Kleinia luzonica* below that of his *Leskia*, and the well-developed plastron and crescentic-shaped peristome of the *Kleinia* show how greatly the forms differ.

Gray termed his species *Leskia mirabilis*, and this has very properly become *Palæostoma mirabile*, Gray, sp.

There are several excellent drawings of the apical system of *Palæostoma mirabile*, Gray, sp., and the last given by Lovén is of course most worthy of study ('On *Pourtalesia*,' &c., plate xvi. fig. 190). Other plates equally exact are in Lovén's 'Études,' plate xii. figs. 103 and 104. In the drawing on the first-mentioned plate, fig. 190, the remarkable appearance of the two large generative pores situated on prominent mamilliform projections is very distinctly rendered. No madreporic plate is to be seen, and the right and left anterior generative plates are not perforated by pores for the ovaries. The drawing shows one perforation on the flank of the right posterior plate and another in the median line, but in the right anterior plate; it is probable that these pores are the feebly developed water-pores. Behind the mamilliform projections there is a space without any signs of sutures, and which is broad posteriorly, where it separates the posterior ocular plates.

In front of the mamilliform projections the right anterior generative plate extends as a narrow and somewhat pointed plate between the ambulacra, and the left anterior plate is of the same general shape, but is smaller and not so pointed in front.

The drawing does not leave the impression that the mamilliform projections are situated upon keel-shaped elevations of the posterior lateral interradia, Nos. 1 and 4. In the outline figure, plate xii. fig. 103, of the 'Études,' the deficiency of sutures in the apical disk is almost as evident as in the finished drawing just noticed.

The only sutural line is that which separates the small left anterior generative plate from the combined plates. There is no plate penetrated by water-pores, and the amount of plate behind the two mamilliform eminences is considerable.

The figure 104 of the same plate of the 'Études' is a view from within of the apical system. It shows the two large generative pores, the small left anterior generative plate, and the united right anterior and right and left posterior plates. But the right anterior plate has no pore or perforations, and it passes backwards, pushing the large pores apart, and reaches behind them and separates the posterior ocular plates somewhat widely. This figure is taken from a young individual whose plates Lovén notices are not distinct.

The meaning of the view from within can be readily understood on reading Lovén's summary of the apical structures (*op. cit.* p. 79)—"*Palæostoma* offers a calicinal system, ... with the five radials [ocular plates] distinct, the I. and V. widely separated [that is, the postero-lateral ocular plates], and out of the costals [generatives, or the basals of one of us], the 3 alone defined by a suture [the left anterior], all the rest being coalesced into one piece; with the madreporic filter represented, in the young specimens examined, by a few punctures placed before the middle, and with the two huge sexual outlets, mammiform and prominent, occupying a considerable portion of the system and placed transversely against the interradials 1 and 4, so as to prevent the retrograde passage of the madreporite." In other words, the madreporite does not pass backwards between the postero-lateral generative plates Nos. 1 and 4.

The peristome of *Palæostoma* is very excentric in front, is small, flush with the test, and of course is five-sided, with the five angles well pronounced. The sides of the pentagon are nearly equal in length, and nearly the whole of each is formed by the margin of a corresponding interradial plate. One cannot but notice the width of the inner (peristomial) part of the interradial plates which bound the mouth, and that whilst these plates occupy so much of the peristomial region, the inner or peristomial plates of the ambulacra are at the angles of the mouth, and hardly enter into the construction of the orifice at all. Broad as the ambulacral plates certainly are, they only touch the peristome with their tops, so that whilst the ambulacra I. and V. form points at the angles of the base of the pentagon, the ambulacra II., III., IV. only form blunter points at their corresponding angles. At the lowest computation the interradial plate No. *1* of each interradium occupies two thirds of that side of the mouth, and the ambulacral plates "*a*" *1* and "*b*" *1* only the remaining third.

The peristome is angular in front and has a straight broad margin posteriorly, the postero-lateral sides of the mouth are of the same breadth as the posterior margin, and the remaining edges of the mouth are equal in dimensions to the others already noticed. It is very important to realize this preponderance of size of the interradial plates No. *1* over those of Nos. "*a*" *1* and "*b*" *1* of the ambulacra. This arrangement is invariable in *Palæostoma*.

There is no downward projecting lip to the plate *1* of the odd interradium, there is no arched margin in front of the mouth, joining the sides of the lip with a narrow curve, and the lower edges of the peristomial marginal plates are not rounded off or otherwise ornamented; they are sunken.

With regard to the critical plates of interradium No. 1, it may be observed, in Lovén's exquisite drawings (pl. xvi. figs. 185 and 187, 'On *Pourtalesia* &c.'), that the broad first plate of interradium No. 1 enlarges in width slightly, and then contracts, being nipped in between the ambulacral plates on either side; it is narrower at that suture which is remote from the mouth than at the peristomial margin.

With regard to the ambulacra of *Palæostoma*. On examining Lovén's plate ('Études,' xxxii. fig. 197) of the spread-out diagram of the test of *Palæostoma mirabile*, and studying the ambulacra I. and V., one is struck with the difference between them; the ambulacrum V. presents nothing unusual except that the plates *2*, *3*, *4* of both rows, "*a*" and "*b*," are broader than is usual—in *Hemiaster*, for instance. The plates are large in relation to those of the corresponding interradium, and the No. *4* of row "*b*" fits in with the posterior lateral suture of the large sternal plate No. *2* of the odd interradium, row "*a*," and the edge of the plate No. *3*. With regard to the ambulacrum No. I., the plate *4* of row "*a*" is moderate in size, and comes in contact with the antero-lateral suture of the interradial (5) plate No. *3*, row "*b*."

The next ambulacral plate, No. *5*, row "*a*," is very large, much larger than the corresponding plate of the row "*b*" of ambulacrum V.; it is broad, and indeed broader than long, and it projects towards the median line. It occupies a part of the space which is left, in consequence of the peculiar arrangement of the plates of the odd interradium, at the posterior part of the sternum, so that its inner part appears to form a portion of the odd interradium (5). The postero-lateral suture of this large ambulacral plate touches the side of plate *4* of interradium 5, and much of it fills up the space between plates *3* and *4* "*b*" of interradium 5.

On looking at Lovén's drawing of the peristomial surface of *Palæostoma* ('Œfversigt af K. Vetensk.-Akad. Förhandlingar,' 1867, p. 434) the remarkable breadth of the ambulacra Nos. I. and V. contrasts with the breadth of the plates of the interradia 1 and 4 &c. An ambulacral plate is as broad as the first or peristomial plate of any interradium.

In plate xxxii. of the 'Études,' fig. 197, the following details can be observed:—The odd or posterior interradium (No. 5 of Lovén) is exceptionally formed, and it does not constitute a plastron; moreover, the arrangement of the plates does not resemble that of other Spatangoids. The plate *1* is broad, but not broader at the peristomial margin than the other first plates of the interradia, but it is long. Behind are plates *2*, but that of row "*a*" is longer than that of row "*b*," and its posterior end reaches backwards almost quite behind plate *3* of row "*b*," to reach and touch the plate "*a*" *3* which is almost in the median line, having both its lateral sutures in contact with ambulacral plates (that is, with the row "*b*" of amb. V. and row "*a*" amb. I.). Plate *2* of row "*b*" is much shorter than the corresponding plate of row "*a*," and it only extends as far back as the posterior edge of the third ambulacral plate of row "*a*,"—ambulacrum No. I., or the right postero-lateral. The anterior suture of plate No. *2*, row "*b*" of interradium 5, is rather wide, and is in contact with nearly the whole of the posterior suture of the first plate of that interradium, and thus the anterior suture of plate *2*, row "*a*," is pushed so far to the true left that a very small portion of the plate comes in contact with plate No. *1*.

The posterior suture of the short plate *2*, row "*b*," is broad and almost forms a right angle with the median suture of the interradium; it is in complete union with the anterior suture of plate *3*, row "*b*." The outer margin of this short plate is in contact with plates *2* and *3* of row "*a*" of ambulacrum No. I. only.

Plate *3* of row "*b*" of the odd interradium is irregularly pentagonal in shape; it is about three fourths the size of the plate in front of it, is larger than the corresponding plate *3* of row "*a*," and is placed altogether anteriorly to this last. Moreover it extends from right to left, over the direction of the median line, and is in contact with no less than five plates. The anterior suture is entirely attached to the interradial plate *2*, row "*b*;" the left-hand suture is in contact with the posterior right suture of plate *2*, row "*a*;" the right-hand suture comes against the fourth and fifth plates of the ambulacrum No. I., row "*a*;" the left posterior suture joins entirely with the right antero-lateral suture of plate *3*, row "*a*;" and the remaining suture, the right posterior, unites with the fifth ambulacral plate of I., row "*a*." The plate now under consideration seems, as it were, to compensate for the shortness of the plate *2* of row "*b*," interradium 5. In Lovén's last work on *Pourtalesia* &c. pl. xvi. fig. 185, there is a most beautiful drawing of *Palæostoma mirabile*. It is of the actinal part of a half-grown individual, and the sutures of the plates are very visible. It shows the great size of the ambulacral plates in relation to the interradials, and it indicates all that has been stated above about the different plates and sutures. Nothing can be more clear than the pentagonal shape of the mouth and the extremely small part played by the ambulacra in forming the margin. In fact, hardly any part of the margin that relates to the interradia Nos. 4 and 1 is produced by the ambulacra; on the other hand, the margins are formed by the very broad ends of the first plates of the interradia 4 and 1. The most conspicuous feature of this part of the test is this preponderance in size of the marginal interradial plates over the marginal ends of the ambulacral plates.

Continuing the description of the interradium No. 5, it is only necessary to remark that the plates *4* of both rows are placed side by side, are united to plate *3* of row "*a*" in front, and not at all to plate *3* of row "*b*;" but there appears to be a slight junction of the interradial (5) plate "*b*" *4* with the large fifth ambulacral of row "*a*," ambulacrum I. Behind these plates (*4* of the odd interradium) are two (*5*) which contribute to the anal opening, and this is completed by the plates *6* and *7* of both rows.

Lovén, in dealing with the Spatangoids without an anal fasciole, and which have a peripetalous one only, states that these Prymnadetes present a certain irregularity in the arrangement of the plates of the bivium. There is an evident tendency towards a constant disposition in the plates called No. *2*, in the lateral interradia 1 and 4; but this tendency is shown in a variable and inconstant manner.

It is the *Palæostoma mirabile*, Gray, a form which is exceptional in many respects, that presents the most singular deviation. Whilst all the other Spatangoids that are still existing, excepting *Urechinus Naresianus*, A. Ag., have in the regular interradia the interradial plate *1*, at the peristome, followed by a pair of plates, the *2* of row "*a*" and the *2* of row "*b*," this genus has this second plate of both rows *confounded in one plate*, and this is seen in all the interradia except the odd posterior one (5). Moreover the interradium No. 1, that is the right posterior lateral, has the consolidated plates *2* row "*a*" and *2* row "*b*" united to the plate "*b*" *3*. This is the only example of this fusion of three plates that is known, and it does not occur in the other interradia of this species. Inasmuch as this fusion does not take place in the interradium No. 4 of *Palæostoma*, abnormal heteronomia of the interradium No. 1 occurs. Lovén terms the union of the plates *2* and *3* of row "*a*" in the interradium No. 1 a normal heteronomia, and remarks that it occurs in the genera *Hemiaster*, *Abatus*, *Agassizia*, *Schizaster*, and *Moira*.

There is a specimen of *Palæostoma mirabile* in the British Museum, and it most unfortunately is adherent by the actinal surface. The shape of the form and the nature of the apical structures can be seen very well. As in the specimens described by Lovén, there are no sutures visible between the apical plates, and the madreporite is not seen between the two perforated generative plates. But there is a little more porosity of the space between the perforated plates than is drawn by Lovén.

II.

In considering the distinctions between *Palæostoma* and *Palæotropus* it is necessary to quote from Prof. Lovén's work on *Pourtalesia*, p. 79. He writes: "*Palæostoma mirabile*, Gray, deviates in a strange manner from nearly all the rest of the Spatangidæ by the fusion into one single plate of the second plates of the interradia 2, 3, 4, the heteronomy of 1 being effected through the union of the plates *a* 2, *b* 2, and *b* 3; by the very irregular interradium 5, and by the pentagonal peristome with its five valves, and from *Palæotropus* in particular, by its distinct petals and by the absence of a subanal, the presence of a peripetalous fasciola. But with all this, *Palæostoma* offers a calycinal system evidently constructed upon the same plan as in that genus," *i. e. Palæotropus* &c. Then follows a summary of the calycinal features, which have been given already. But that part of the description which relates to the madreporite is given so definitely by Lovén that it may well be given again, especially as the statement affects this reply in a very decided manner. Lovén notices that the two mammiform and prominent sexual outlets are placed transversely against the interradials 1 and 4, so as to prevent the retrograde passage of the madreporite.

The point in the argument that we wish to make after this comparison of the two genera is exceedingly simple, and it is that Prof. Lovén admits certain structural differences in *Palæostoma* to be of sufficient importance to override the similarity of the calycinal structures which the genera have in common.

It is clear that, like any other naturalist, Lovén admits that although two forms possessing some similar and important structures are closely allied, yet if there are some other and very decided structural differences between the forms they cannot belong to the same genus. *Palæostoma* is not the same genus as *Palæotropus*, because, although there are some points in common about the apical disk, there are others, elsewhere, which are not so. The same elementary reasoning will apply to any other genera which may have some, but which may not have all, of the principal characters of *Palæostoma*. In concluding this part of our reply, we can state that *Hemiaster elongatus*, nobis, having some structures in common with *Palæostoma*, possesses many more which do not characterize the genus in which Prof. Lovén would place it. The same remark holds good for the species *Hemiaster digonus*, d'Archiac.

III.

The following description of *Hemiaster elongatus*, nobis, is taken from the work quoted by Prof. Lovén, named 'A Monograph of the Fossil Echinoidea of Sind, collected by the Geological Survey of India, from the Palæontologia Indica, series xiv. Fasc. 2. The Ranikot series.' We only refer to those points which bear especially upon the diagnosis.

On page 79 it is stated as follows :—"The apical system is compact and small, the madreporic body is small, *and separates the posterior ocular plates*, but does not extend into the posterior interradial area; there are only two generative pores, and they are situated on the tops of truncated cones, *separated at their bases by the granular surface of the madreporic.* The cones are at the extremities of a narrow transverse ridge. The right and left antero-lateral generative plates (2 and 3) are very small, and they are not perforated by generative pores; and the postero-lateral plates are the largest and are perforated. There is no posterior generative plate. The ocular plates are well developed, and are placed in hollows, and intrude on the generative plates. The apical system is slightly behind the centre of the test, is small, and is situated on a narrow transverse keel of the lateral interradia."

The madreporic body is continuous with plate 2, the right anterior, and is perforated by numerous pores; but as the extension of the pores on to the plates on either side is only tolerably visible in one specimen, we have a doubt upon this matter. The separation of the posterior oculars Nos. I. and V. by the madreporic body is most decided, and our fig. 9 on plate xix. is quite correct. This body is most certainly not prevented from passing backwards by the costals 1 and 4 of Lovén: on the contrary, it passes between these plates, separating them widely, in a manner perfectly foreign and opposite to what is seen in *Palæostoma* and *Palæotropus*.

The peristome is, as stated in our Monograph, placed very excentrically in front, is small, *much the longer transversely*, has a rim, and is *round at the sides.* It is also mentioned that the lip on the *anterior end of the plastron* is slightly prolonged downwards. The drawing in pl. xix. fig. 8 shows the projecting posterior lip, and fig. 10 indicates that the posterior lip is on *a lower level* than the front of the actinal part of the test. As we considered the species to be a *Hemiaster*, there was no necessity to enlarge upon the very characteristic peristome in the specific description; but in order to place the form in a proper antagonism to *Palæostoma*, which was so named in consequence of its supposed ancient and therefore pentagonal shape, we now give the details in full.

The peristome is *rudely crescent-shaped* and is broader than long. The anterior margin is *broad and curved*, with the convexity forwards, whilst the posterior margin is rather narrow from side to side, and *is curved*, but less so than the anterior edge, the convexity being forwards. The anterior margin is prolonged *backwards, on either side*, behind the line of the projection of the posterior lip, and ends in a rather narrow rounded angle on either side. The edges of the plates forming the margin are turned forwards and backwards, according to their position, and this is particularly observable on the posterior lip. This lip projects downwards in the median line and is at its edge lower than that of the front lip and the sides of the mouth. *In specimens which are less than one half the size of the type figured, the peristome is of the same shape as in the adults : all the difference is that in the smaller forms the aperture is a little more open than in the others. There is not the slightest approach to an equal- or unequal-sided pentagon in the shape.*

In the remarks we made on the species, at the close of the descriptions of the Ranikot Echinoid fauna (p. 96), it is stated that "The shape of *Hemiaster elongatus*, which is a very common fossil, is remarkable ; and its structural details separate it from others. The presence of only two generative pores situated on mamelons, and the fact that the madreporic body passes backwards and separates the ocular plates, make the form to look much more modern than the Nummulitic."

On reconsidering this description we do not find that there is anything material to alter. But to place our species more definitely we may state that the madreporic body is continuous with the small right antero-lateral generative plate (No. 2), and that it is distinctly separated from the generative plates on either side of it (Nos. 1 and 4) *by sutures.* The small left antero-lateral plate (3 of Lovén) is separated from the madreporic and from the left posterior lateral plate (4 of Lovén) by sutures. *In other words, there are sutures limiting all the generative plates.* Nothing can be more decided than the pushing aside of the plates perforated by the ovarian pores, by the suturally defined and limited madreporic body.

The margin of the peristome is composed of ambulacral plates mainly ; the interradia enter in very slightly, except in the instance of the posterior or odd one (No. 5 of Lovén). This interradium *has a plastron*, and the ambulacra are sunken on either side of it, and the plastron is on a lower level than the rest of the actinal surface. The first plate (No. *1*) of this interradium (No. 5) is much the broadest of all the corresponding plates around the mouth, and it is "cheese-knife" in shape—that is, convex at one end and broad, but narrowing behind to an almost straight handle. The convex part nearly forms the whole of the posterior lip of the peristome, but parts of it are made up of ambulacral plates, and these indent the sides of this first interradial plate and produce the peculiar shape of its sides. Plates *a 2* and *b 2* of interradium 5 are very long; they unite along the median line by a straight suture, and are in contact with plate *1* by means of a narrow forwardly curving suture, the breadth of the suture of "*a*" and "*b*" being equal. The plate *a 2* is longer than plate *b 2*; both are narrow, widest in the middle and becoming narrower backwards. The smaller plate *b 2* unites posteriorly with plate *b 3*, and the long plate *a 2* is in contact posteriorly with plate *a 3*, and also by its proper right posterior suture with plate *b 3*. The plates *a 3* and *b 3* are in contact by the left posterior suture of *b 3*, and both of these plates are sutured to plates *a 4* and *b 4* respectively. The plates *a 4* and *b 4* are larger than plates 3.

The following is the arrangement of the ambulacral plates in relation to the several interradial plates of interradium 5. The narrow part of plate *1* is in contact with the large ambulacral plate amb. I. *a 1*, and the following ambulacral plate *a 2* and one half of plate *a 3* are also boundaries of the large interradial plate 1. The remaining half of ambulacral plate *a 3* and all of *a 4* and part of *a 5* limit the interradial plate *b* 2. *Now it is important to observe that the posterior half of the ambulacral plate a 5 is in contact by suture with the interradial plate b 3, but not with a 3, for that is on the further side of b 3; moreover the ambulacral plate a 5 does not encroach towards the median line.*

This description refers to the usual condition of the interradium, but there are occasional departures from the normal, which, however, do not affect the argument. Thus in one instance the interradial plate *a 2* is crossed by a suture on a level with the posterior suture of the ambulacral plate *b 2* of zone V., but the arrangements of the interradial plates further back is the same as in the type.

With regard to the width of the ambulacral plates it is evident that as a whole they are narrow; the plates *a 1*, *b 1*, and *a 2*, *b 2* of ambulacrum I. are broader than the following plates *3* and *4* of *a* and *b*. Plates *a 5* and *b 5* are broader than those just noticed, are placed side by side as is usual in

Hemiaster, and are followed by two smaller plates. *There is no resemblance between this arrangement and that of Palæostoma.*

Interradium 1 has its plates visible on the actinal surface in some specimens, and its plate *1* has a very small edge at the peristome, where it forms the margin of the narrow blunt angle. The space occupied by this and indeed all the interradia at the margin of the peristome, except the interradium 5, is much less than that presented there by the ambulacral plates. Although the peristomial part of plate *1* is narrow, the rest of it gradually increases in width, so that at the level of the third ambulacral plate of ambulacrum I. it is very broad, stretching across the interradium 1, and having a slightly curved posterior suture, which can be traced from plate *b 3* of ambulacrum I. to *a 3* of amb. II.

The plate *1* is followed by *two plates* : *one is b 2 and the other is the combined a 2 and a 3*, these last forming the larger plate of the series. The plate *a 2* is in contact with the ambulacral plates *3* and *a 4*, of amb. II. (one half of each), and on the opposite side it is sutured to plates *2* and *3* of interradium 1. This combined plate comes in contact with the ambulacral plates *4*, *5*, and *6 b* of amb. I.

There is no union of the plates so as to form an unusual heteronomia; on the contrary the arrangement of the plates is exactly as it is in the species of the genus *Hemiaster*—*H. expergitus*, Lovén, for instance.

In interradium 4 there is the usual double row of plates *a 2* and *b 2* following plate *1*, and there is no union of any others as in *Palæostoma*.

So far as *Hemiaster elongatus*, nobis, is concerned, it has not the characteristic heteronomia of *Palæostoma mirabile*, Gray.

IV.

Hemiaster digonus, d'Archiac, was first fully described by MM. d'Archiac and Haime in their great work 'Sur les Animaux fossiles de l'Inde,' p. 220. Subsequently we examined a large collection of very indifferent specimens from the Khirthar series of Sind, and we published the results in our monograph 'On the Fossil Echinoidea of Western Sind' (Pal. Indica, ser. xiv. fasc. iii. p. 200). We gave careful drawings of as much of the tests as we could on plate xxxv. figs. 4–9.

The species is characterized by the short, broad, posteriorly elevated test, the great width of the odd ambulacrum and of its groove, and the position of the apical system rather far back. But the principal character which it has in common with *Hemiaster elongatus* is the presence of two large generative pores, each placed upon a conical process; the apical system is, moreover, small.

The madreporic plate is *continuous with the generative No.* 2, and is placed *between the two large pored plates Nos.* 1 *and* 4, *which it separates widely, and from which it is partitioned off by distinct sutures.* The madreporic also extends *behind* those generative plates, and *separates the posterior oculars I. and V.* nearly as much as it does the generative plates 1 and 4. It extends backwards behind the line of the ocular pores and ends in a peak-like process, which slightly separates the long pair of interradial plates of the odd interradium.

The generative plate 3 is very small and broader than it is long; it is separated from the madreporic and from the generative plate No. 4 by sutures. There is no fifth plate. Both of the conical and perforated plates 1 and 4 are limited by sutures, and the water-pores are upon the madreporic plate only. The ocular plates are rather large.

On the actinal surface the peristome is seen far in front and to be *crescent-shaped*; it is broader than long, has a curved front lip and a downward-projecting curved posterior lip. The plate *1* of interradium 5 is broad at the margin of the mouth; but the corresponding plates of the other interradia are very narrow there. As is invariable in more or less adult *Hemiasters*, the ambulacral plates contribute to the peristomial margin more than the interradials. Unfortunately the peculiar saccharine-looking fossilization prevents the sutures of the plates of interradium 1 being seen; but in one specimen it is clear that the first plate is large and of the same shape as in *H. elongatus*; moreover, what can be seen of the following plates indicates that there are two, and not only one behind the first. There is no unusual heteronomia.

There is a distinct plastron.

V.

It is evident from what has been stated regarding the essential and characteristic structures of the three forms, *Hemiaster elongatus*, *H. digonus*, and *Palæostoma mirabile*, that the first two are closely allied, there being only some specific distinctions between them, such as the shape of the test, the breadth of the odd ambulacrum, and the greater length of the generative plate 3 in the first-named *Hemiaster*. It is also evident that these two species can be separated in almost every essential structural detail from the species of *Palæostoma*.

Having put forward the several points which characterize the genera under consideration, it is only necessary to compare the forms one with another.

We may admit that the two species of *Hemiaster* differ equally from *Palæostoma.*

In all the forms the apical system is small, and two of the generative plates, 1 and 4, have conical eminences, on which are the large ovarial pores.

In all three forms the generative or basal plates 2 and 3 are small and without perforations for ovarial ducts, and here the structural similarity ceases. The genus *Palæostoma* has no madreporite passing back between the two perforated plates 1 and 4 ; the other two forms have this, and, moreover, the madreporite reaches back between the posterior oculars I. and V. There are no sutures in *Palæostoma*, but they are present between all the plates in the forms we have called *Hemiaster.*

The peristome of *Palæostoma* is pentagonal at all ages ; that of our *Hemiasters* is never pentagonal, and is of the crescentic shape of the genus, the front edge being curved widely and the back lip being also curved and projecting downwards as a prominent structure. In *Palæostoma* the interradial plates *1* at the margin of the mouth are large, nearly equal in their considerable space, and the ambulacral plates contribute but slightly to the margin. In the other forms only the plate *1* of interradium 5 is large, and, as in all *Hemiasters*, the other first plates barely contribute to the peristome, whilst the greater part of the margin is made up of the ambulacral plates. The first interradial plates of 1, 2, 3, and 4, not very wide posteriorly in *Palæostoma*, are decidedly wide in the *Hemiasters*.

There is a most remarkable heteronomia of the interradium 1 in *Palæostoma mirabile*, but there is nothing of the kind in the two other forms. They present the normal heteronomia of the interradia, actinally, which is usual to such Spatangoids. There is no plastron in *Palæostoma*, but there is in the other forms.

The very broad ambulacra on either side of the odd interradium in *Palæostoma*, are not characteristic of the *Hemiasters* ; on the contrary, their ambulacra are narrow. In *Palæostoma* there is a remarkable enlargement of the fifth ambulacral plate of amb. I. row *a*, and it is pushed to the left because plate *b 3* of interradium 5 is placed so much to the front of *a 3* of the same interradium that there is a vacant space. This is not the case in the two species which we have named *Hemiaster*, and plates *a 3* and *b 3* of the odd interradium are as is usual in the Spatangoids.

We consider that we have proved that the generic characters of *Palæostoma* are not present in the form we named *Hemiaster elongatus*, nor are they in the closely allied species *H. digonus*.

VI.

Prof. Lovén remarks in his work on *Pourtalesia*, p. 75 :—"In the adult of *Hemiaster* and of all the other Spatangoids of early Mesozoic origin the calyx in the adult presents a structure essentially different from that of the calyx in the adult of a *Spatangus* or of any other form of later or recent appearance, and very rarely a link is found between the two." On page 73 of the same admirable work there is the following statement in reference to *Hemiaster* :—"Now these three species of the existing seas are true *Hemiasters*, fully sharing the well-known characteristics of that highly natural genus, the subglobose form, elevated in its posterior region, a calyx of four costals [generative plates], the madreporite confined to costal 2, the 4 and 1 and the radials I. and V. closing from either side, in strict accordance with the mode of conformation universally prevalent within the calycinal system during the older Mesozoic period."

Lovén then compares this calicular or apical arrangement of the *Hemiasters* with that seen in the genus *Abatus.* This he shows has five generative plates, "the 5 being reproduced between the radials I. and V., and bearing the madreporic filter, thus set free, on its unimpeded retrograde movement." He asserts that if a form like this is allowed to remain in the genus *Hemiaster* its integrity is vitiated.

Under any circumstances the two forms we have described as *Hemiasters* are closely allied to *Abatus*, but they have no basal ("costal") plate 5, and the madreporite is clearly on the plate 2 ; moreover, the Sindian forms never have three generative pores. *Abatus* has the same arrangement of the interradial plates on the actinal surface in areas 1 and 4 as the two *Hemiasters* from Sind; the plates of the ambulacrum No. I. are more numerous in *Abatus* than in our *Hemiasters*; but the shape of plate 1 of interradium 5 of both forms is the same. Comparing the Sindian *Hemiasters* with the recent *H. expergitus*, it will be noticed that the details of the actinal surface correspond; but on the apical disk the madreporite of the recent form does not pass between the plates 1 and 4. The correspondence is not very close, however, in dimensions, for the ambulacra on either side of interradium 5 are broader in the recent form, and the front part of the peristome is not with a prominent rim. Considering the two species to belong to the same genus, one would say that the specific difference is in the position of the madreporic plate.

With regard to *Hemiaster zonatus*, A. Ag., the notice in the 'Challenger' Echini gives no structural details.

Hemiaster gibbosus, A. Ag., agrees with the Sindian forms in every generic detail, except in the structure of the apical disk.

Of course the whole question of the value of such generic forms as *Abatus*, *Tripylus*, &c., depends upon the greater or less importance of the presumed fixity of the position of the generative plates. We cannot agree to the hard-and-fast lines regarding *Hemiaster* laid down by Lovén, because we believe that the position, as well as the number and perforation of the costals of Lovén (the basals of one of us) are variable, and more so than the details of the actinal structures. With some other naturalists we consider all these forms to be simple groups of *Hemiaster*, some being possibly of subgeneric value.

It is somewhat singular—and we believe it shows our appreciation of Lovén's generalization, that the madreporite tends to pass backwards in Tertiary and recent species of Mesozoic genera—that we should have been impressed with the position of the madreporite in the Sindian forms as indicating a variation that should be found in Tertiary *Hemiasters*.

The researches of M. P. de Loriol in our opinion confirm the propriety of separating *Palæostoma* and the *Hemiasters* with only two generative pore-openings and an encroaching madreporite. M. de Loriol published in the 'Palæontographica' (xxx.) a work entitled "Eocäne Echinoideen aus Aegypten und der Libyschen Wüste" (1881), and in it are two most interesting forms which bear considerably on the subject before us. In the Libysche Stufe there is a *Palæostoma*, and in the same deposit there is a *Hemiaster Schweinfurthi*, both species of de Loriol's. *Palæostoma Zitteli* (p. 33, pl. viii. figs. 1–1 *d*) is closely allied to *P. mirabile*; the shape of the test and that of the peristome are the same, but the pores of the ovarian plates "sind nicht deutlich zu erkennen." The peristome has all the characters of *Palæostoma*, but none of *Hemiaster elongatus*—"Peristom nahe am vorderen Rande in gleicher Ebene mit der Schale, genau fünfeckig, mit beinahe gleichen Seiten. Der Umriss ist durch eine deutliche Leiste eingesäumt."

This interesting fossil form in no way resembles our *Hemiasters*. *Hemiaster Schweinfurthi* is described on page 34 and figured on the plate viii. figs. 3, 4, 5.

This *Hemiaster* has but two generative pores, "Nur die Genitalporen der beiden hintern paarigen Interambulacralfelder entwickelt, Madreporenplatte klein, in der Mitte gelegen." The plates represent a true *Hemiaster* so far as shape, fasciole, peristome, and ambulacra are concerned. The two generative pores are not upon cones, but they are wide apart, and it is stated in the description of the plate that the indistinct madreporite has not been rendered by the artist. Its place is evident enough between the posterior costals 1 and 4 of Lovén. De Loriol remarks that the form belongs to a group of the genus *Hemiaster* in which there are only two, and rarely three, genital pores (instead of four) in the apical disk. He notices that *H. cavernosus* sometimes has only two, seldom three pores, and he evidently takes the view that this diminution of the number of generative pores is not to remove the forms from the genus *Hemiaster*, all other generic characters being the same. Amongst these characters the presence of a madreporic between the posterior ovarial plates does not, in the eyes of this very exact and careful zoologist, militate against the species thus endowed being a *Hemiaster*. De Loriol's work shows that the number of the pore-bearing plates is a variable quantity, and that too much must not be made of the occurrence in classification.

In concluding this reply to the criticisms of Prof. Sven Lovén, we restore the form which he has removed into the genus *Palæostoma* to its original position in the genus *Hemiaster*, and its fellow species from the higher Tertiary horizon must also be associated with it. The Ranikot and Khirthar Sindian Nummulitic *Hemiaster elongatus*, Duncan and Sladen, and *Hemiaster digonus*, d'Arch., retain those classificatory terms. We trust that the distinguished naturalist, from whom we have both learned so much, and for whom we entertain a sincere admiration, will receive this reply in the same spirit which prompted him to notice our work in his great essay on *Pourtalesia*.

Note.—We have used the term "interradium" throughout this paper because it is customary; but it should certainly be interradius.

September 1884.

XXIX.—*Aspects of the Body in Vertebrates and Arthropods.* By A. S. Packard*.

Under the title 'Aspects of the Body in Vertebrates and Invertebrates' (London, 1883) the venerable and distinguished English anatomist and palaeontologist, Professor Sir Richard Owen, renews in a vigorous way the old discussion originally begun by Geoffroy St.-Hilaire. The view in question is tersely presented in St. Hilaire's answer to Dugès, quoted by Professor Owen, when he replied by reference to "Fig. 2 de la septième planche: Là se trouve effectivement représenté un homard couché sur le dos et montrant distinctivement ses viscères dans la position où le sont les viscères des mammifères placés sur le ventre." This view was combated by Cuvier, and in this respect he has been followed by Gegenbaur.

In his able essay Professor Owen places himself on the side of St.-Hilaire, and the special point in vertebrate anatomy which he brings forward to support this opinion is the homology of the conario-hypophysial tract, which he regards as "the modified homologue of the mouth and gullet of invertebrates;" and at the end of chapter i. he concludes that "the surfaces or aspects of the body which are truly homologous in the snake and caterpillar are the *neural* and the *hæmal*, not the *dorsal* and the *ventral*."

In his second chapter, entitled "Cerebral Homologies in Vertebrates and Invertebrates," Professor Owen quotes our statement† that "the brain and nervous cord of the fish or man is fundamentally different, or not homologous with that of the lower or invertebrate animals," and then proceeds to criticize it.

The chapter on the brain of the locust was written for the unscientific as well as the scientific reader, and the introductory part was presented in a terse, perhaps dogmatic way, for the sake of clearness.

The author, without taking time and space to discuss at length this broad question, which requires a far wider acquaintance with anatomy and embryology than he claims to possess, would beg leave to briefly present some facts and considerations which seem to him to support the view he adopted as to the lack of homology between the nervous system of Arthropods and Vertebrates.

* From advance sheets of the 'American Naturalist,' Sept. 1884, pp. 855–861, communicated by the Author.

† Second Report U. S. Entomological Commission, chap. xi., "The Brain of the Locust," p. 224 (1880).

These facts relate to the histology and the histological topography as well as the general morphology of the system in question, and to the general relation of the viscera to the body-walls of Arthropods as compared with Vertebrates.

1. *Histology.*—There are but two histological elements in the brain and spinal cord of Vertebrates, *i. e.* ganglion-cells and nerve-fibres proceeding from them. In Worms (and Mollusks so far as known) and especially in the brain (procerebrum, as we may call it to distinguish it from the cerebrum of Vertebrates) and other ganglia of Crustacea and insects, besides these two elements there is a third substance, the *Punktsubstanz*, discovered by Leydig, and further described by Dietl and Krieger, and for which we would suggest an English equivalent, the *myeloid substance*.

2. *Histological Topography.*—The arrangement of the ganglion-cells and other tissues in the ganglia of Arthropods is not homologous with that of Vertebrates. In the brain or any of the postœsophageal ganglia of Arthropods there is a central mass formed of the myeloid substance, which is enveloped by a cortical layer of mostly unipolar ganglion-cells. The fibres from the ganglion-cells pass into and emerge again from the myeloid substance, which is a tangled mass of minute fibrillæ. The fibres from certain of the ganglion-cells we have clearly seen to pass through or over the myeloid substance and to form both the transverse commissures of the brain and also the two main longitudinal commissures connecting the chain of ganglia. But the fibres from the majority of the ganglion-cells appear, as Leydig holds, to break up into the tangled mass of extremely fine fibres, which, when cut through, presents a dotted or granulated appearance. This myeloid substance remains unstained, while the ganglion-cells readily stain by reagents.

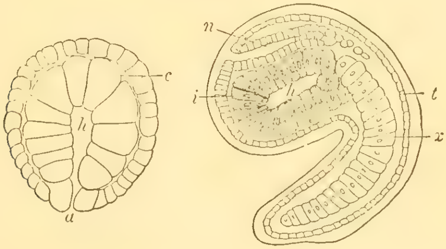
In the brain and other ganglia of vertebrates, on the other hand, the ganglion-cells are internal, the fibres arising from uni-, bi-, or multipolar ganglion-cells passing outside. In Invertebrates, at least in Arthropods, there is no "white" or "grey" substance; none such has been described by Leydig or the later students of the central nervous system of Arthropods.

Histogenesis.—If we look at the genesis of the ganglia of Arthropods, we see that they consist at first wholly of spherical cells, the fibres and myeloid substance being secondary products, and their position is not homologous with that of the ganglia in vertebrate embryos. The reader is referred to fig. 246 in Balfour's 'Comparative Embryology,' vol. ii. p. 343. The section of the spinal cord of a seven-days' chick there figured shows that the cord is early differentiated into the internal grey mass, consisting of round cells, enveloping the spinal canal, while the cortical white substance or column surrounds the mass of ganglion-cells. In the Annelidan worms and the Arthropods the embryonic ganglion is a much simpler structure, consisting of a mere mass or ball of ganglion-cells with incipient fibres passing from them. Certain of these fibres grow longer, forming the commissures, transverse and longitudinal, connecting the ganglia. At first, then, the nervous system of the higher worms (those with a ganglionated chain) and Arthropods consists of a series of disconnected ganglia, which eventually become connected by secondary products, the commissural fibres. The fact that in Worms the brain is at first separated from the rest of the ganglia, as stated in Balfour's 'Embryology' (i. p. 291), is not of particular significance, since all the ganglia, at least in Crustacea and insects, are at first disconnected from each other.

Embryology appears to give no countenance to the view held by some authors that the brain of an Arthropod may represent the nervous system of the Vertebrate, and the post-œsophageal chain of ganglia the sympathetic system of the Vertebrates.

There seems to be a unity of plan, so to speak, in the development of the nervous system of the Arthropods, and how

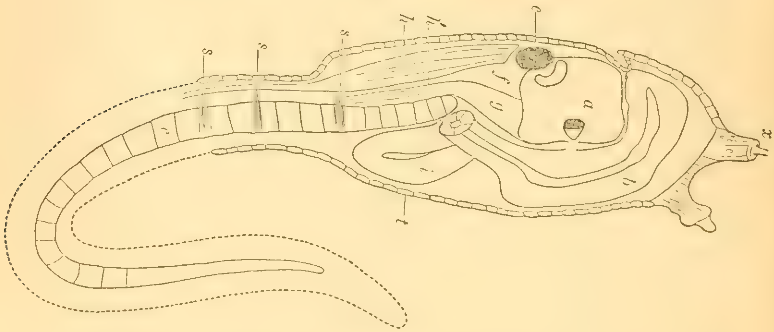
Fig. 1.



Early stage of Ascidian embryo, showing the nervous tube *n*, open in front and situated dorsally above the alimentary tube (*h*), as in Vertebrates.

radically different that is from the mode of genesis of the vertebrate nervous system may be seen by reference to Balfour's work (ii. pp. 250–252) or those of other observers. While the nervous system of all animals arises from the ectoderm (epiblast), as Balfour states: "In all Chordata an axial strip of the dorsal epiblast, extending from the lip of the blastopore to the anterior extremity of the head, and known as the medullary plate, becomes isolated from the remainder of the layer to give rise to the central nervous axis ;" in Tunicates as well as Vertebrates this plate is converted into a tube or canal, which lies wholly above the alimentary tract. It is this striking feature in embryo Tunicates which mainly seems

Fig. 2.

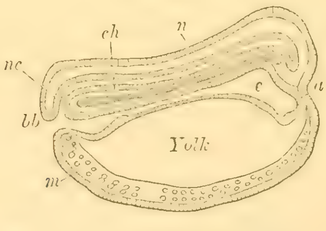


Embryo of an Ascidian, showing the vertebrate plan of structure; the nervous system (h', h) with the spinal nerves (s) being situated dorsally above the notochord (c) and alimentary canal (b, i).

to justify their elimination from the Worms and indicates their proximity to the Vertebrates, as this seems to be a more truly vertebrate feature than even the possession of a notochord.

Balfour states on p. 342 :—" The spinal cord, shortly after the closure of the medullary canal, has, in all the true Verte-

Fig. 3.



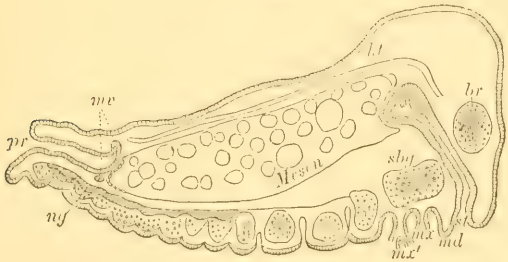
Section of a vertebrate embryo (a fish): n, nervous tube, open in front and situated dorsally; ch, notochord; bb, mouth; e, alimentary canal; a, place of vent; m, mesoderm.

brata, the form of an oval tube, the walls of which are of a fairly uniform thickness, and are composed of several rows of elongated cells. This cord, as development proceeds, usually becomes vertically prolonged in transverse section, and the central canal which it contains also becomes vertically elongated." Then follows the differentiation (1) of the epithelium of the central canal, (2) of the grey matter of the cord, and (3) of the internal coating of white matter. "The white matter is apparently the result of a differentiation of the outermost parts of the superficial cells of the cord into longitudinal nerve-fibres, which remain for a long period without a medullary sheath. . . . . The grey matter and the central epithelium are formed by a differentiation of the main mass of the spinal cord."

There thus appears to be a lack of homology in the histological topography and origin of the nervous system in Chordata as compared with the Annelidan worms and the Arthropods.

The relation of the nervous system of Arthropods is constant; after the stomodæum has been formed, commissures from the brain pass down and connect the latter with the subœsophageal ganglion, which is ventral. This relation of the postœsophageal nervous system to the ventral side of the

Fig. 4.



Relations of the nervous system of an embryo Orthopterous insect to the body-walls: *br*, brain; *sbg*, subœsophageal ganglion; *ng*, nervous cord; *st*, stomodæum; *pr*, proctodæum; *mv*, malpighian tubes; *mesen*, mid-intestine; *ht*, heart; *md*, mandibles; *mx*, *mx'*, 1st and 2nd maxillæ. From Ayers, with changes.

body is as constant as the disposition of the ventral surface of the embryo of Insects before the revolution of the embryo, or of the embryos of Annelid worms and Crustacea. The position of the Arthropod embryo is the reverse of that of Vertebrates. The vertebrate disposition of the primitive nervous system is also seen in the embryo Tunicate (figs. 1, 2).

Morphology.—The brain of the Arthropoda is contained in a structure which throughout is lacking in homology with that of Vertebrates. The crust, the segments, and the appendages especially have nothing in common with Vertebrates, though the functions are in a degree the same. The origin and homologies of the sensory organs are *ab initio* different. For example, the eyes of Arthropods are not truly homologous with those of Vertebrates; the cornea is simply a number of epithelial cells, while in Vertebrates the eye externally is an ingrowth of the epiblast. As the wings and legs of insects and organs of hearing and of smell are not the homologues of the parts which function as such in Vertebrates, so we are not inclined to regard the heart and nervous system of Arthropods as truly homologous with the corresponding organs of Vertebrates. If there is such a fundamental difference in the two types as regards the relations of the viscera to the body-walls, and if this relation is common to all Arthropods and the Annulata, we shall have to go back to the hypothetical common ancestors of the Tunicates and Vertebrates on the one hand, and of the Annulata and Arthropoda on the other, for the means of comparison. It is not impossible that in animals allied to the Planarian or Nemertean worms, whose nervous system consists of a pair of dorsal ganglia, with two or more pairs of nerves passing backward, that the common origin of the prochordate nervous system and that peculiar to Annelids and Arthropods may yet be discovered.

So also the resemblance of the brain, dorsally situated, of the Cephalopods, enclosed as it is in an imperfect cartilaginous capsule, is interesting; but the relations are those of analogy or adaptation, and not of affinity. The Mollusks, the Annelids, the Arthropods, and the Vertebrates appear to be highly specialized branches, and where there appear at first sight to be direct cross-homologies, so to speak, between them, these are rather independent structures, the result of adaptation rather than of direct descent. Examples of such, we believe, are the eye, the brain, and the heart of the Cephalopods.

The unity of organization in the animal world is seen rather in the homology of the cellular structure and in the common origin of all from unicellular forms, and among the Metazoa in the identity of the morula and gastrula conditions, or at least the germ-layers; and as regards the nervous system, in its origin in the epiblast, rather than in any special parts or organs of such highly elaborated and specialized types as are represented by the lobster, or butterfly, or fish.

The dispute between Cuvier and St.-Hilaire and their followers was in part metaphysical. The old-time problems in transcendental anatomy, such as comparing a lobster to a vertebrate upon its back, the problems of fore-and-aft symmetry, and the question of torsion in the fore and hind limbs of Mammals, have, if we are not mistaken, lost much of their interest and value in the light of modern evolutionary problems, and savour more of scholasticism than of science.

At all events the present problem is, as embryology shows, so remote in its bearings,—the common point of origin of Arthropod and Vertebrate, the fork in the primitive developmental path where the two branches began to diverge, is set so far back in the animal scale, and is so remote in geological time, that with our present knowledge we are inclined to regard the consideration of such problems as belonging rather to metaphysics than to pure science, although it should be granted that further researches among the lower worms may yet result in the discovery of facts bearing upon the origin of the singular differences in the disposition of the arthropod and vertebrate nervous systems.

In conclusion, therefore, we are led to endorse the following opinion of Gegenbaur, in his 'Comparative Anatomy' (English translation):—"The greater size of the cephalic ganglion compared with that of the ventral ganglia has been already seen in many of the Annulata; in the Arthropoda it is ordinarily still more distinct; this condition may be partly explained by its relations to the more highly developed organs of sense, if we recognize in the dorsal œsophageal ganglion something similar to the brain of the Vertebrata. Led by an idea of this kind, some have compared even the ventral ganglia or ventral medulla with the dorsal medulla of the Vertebrata, and have striven to carry the comparison still further; these attempts ignore the complete difference between the type of structure of the Arthropoda and of the Vertebrata" (p. 252).

XXX.—*A Contribution to the Knowledge of the Freshwater Sponge* Dosilia Stepanowii. By Dr. M. Dybowski*.

In the description of the freshwater sponge, *Dosilia? Stepanowii* †, recently published by me, I left its gemmules entirely out of consideration, because none were present in the

* Translated by W. S. Dallas, F.L.S., from the 'Zoologischer Anzeiger,' no. 175, September 1, 1884, p. 476.

† Dybowski, "Notiz über die aus Süd-Russland stammenden Spongillen," in Sitzungsb. d. naturf. Gesellsch. d. Univ. Dorpat, Band vi. p. 507 (translated in this journal for July 1884, p. 58), and 'Travaux de la Société des Naturalistes de l'Université de Charkow,' vol. xvii. (1883), p. 289, pl. vii. fig. 1 *a–d*, in Russian.

material then in my possession. In order to complete the knowledge of this fine and exceedingly interesting sponge I propose now to give as accurate a description as possible of the gemmules. The figures that I have prepared will appear shortly in the publications of the Society of Naturalists of the University of Charkow. For the material upon which my investigations are based I am indebted to the kindness of my friend and *collaborateur* Prof. P. T. Stepanow.

The above-mentioned material is from the Government of Charkow, and consists of two small spirit-specimens furnished with gemmules.

One specimen in which the gemmules exist within the parenchyma is a fragment of a larger sponge. This sponge is from Lake Wielikoje and was presented to the University Museum by a student, M. Radkiewicz.

The other specimen is a small, nearly perfect sponge, coating the surface of the leaf of a tree in a very thin layer. In this the gemmules are placed in a group at the base of the sponge, and consequently on the surface of the leaf. This latter specimen was found (on August 5, 1883) by another student, M. J. W. Riabinin, in a small lake, connected with the river Daniec, in the neighbourhood of the village of Kotschetvök.

Referring to my previous writings (*l. c.*) for the characters of the sponge *Dosilia? Stepanowii*, I now pass to the description of the gemmules.

The gemmules are spherical, more or less dark horny-brown coloured vesicles, 0·3–0·5 millim. in diameter, in which the following parts may be distinguished:—

1. The gemmula-capsule;
2. The coating-layer;
3. The pore;
4. The pore-appendage; and
5. The germinal matter.

If we examine under the microscope (Hartnack obj. no. 4) a section passing through the whole gemmule (including the pore), or an entire (sufficiently transparent) gemmule in profile (which in this case is much better), all the above parts, to the description of which we shall now pass, may be very distinctly recognized.

1. The Gemmula-capsule (Vejdovsky's "Chitinmembran"*; Carter's "chitinous coat"†).

The capsule of the gemmule consists of a structureless,

* F. Vejdovsky, "Die Süsswasser-Schwämme Böhmens," in Abhandl. k.-k. Böhm. Gesellsch. d. Wiss. ser. 6, Bd. xii. p. 33.

† H. J. Carter, Ann. & Mag. Nat. Hist. 1882, pl. xiv. fig. 2 &c.

chitinized membrane, 0·004 millim. thick, the colour of which is a darker or lighter horn-brown. The capsule passes directly into the pore (*vide infrà*). The capsule is covered externally with a thick layer, the *coating-layer*, and filled with the germ-material.

2. THE COATING-LAYER (Belegschicht; Vejdovsky's "Parenchymschicht" *; Carter's "spiculiferous layer").

The whole surface of the gemmula-capsule (with the exception of the pore) is covered (coated) with a layer 0·026–0·030 millim. thick, which exhibits the following parts:—*a*, the amphidisci; *b*, the intermediate structure; and *c*, the outer membrane (*Oberhäutchen*).

The *amphidisci* (as is also the case in some other Spongillæ) are siliceous, spindle-shaped corpuscles (see Trav. Soc. Nat. Charkow, pl. vii. fig. 1 *b*), which stand close to each other perpendicular to the surface of the capsule.

The shafts of the amphidisci are comparatively very long and slender (*vide infrà*) and have on the surface large, erect, but rather scattered spines (*ibid.* fig. 1 *b*). Within the shaft runs a canal furnished with organic matter, which, in calcined preparations, appears as a black, opaque, longitudinal streak †.

The margins of the terminal disks of the amphidisci, the diameter of which is 0·008–0·012 millim., are deeply notched and furnished with numerous small denticles.

The amphidisci occur of two different forms, namely *longer* (of 0·040 millim. in length and 0·002 millim. in thickness) and *shorter* (of 0·024 millim. long and 0·002–0·004 millim. thick). The *shorter* amphidisci, which considerably exceed the longer ones in number, are entirely enclosed within the coating-layer, and do not extend beyond the outer membrane; the *longer* ones, on the contrary, protrude by their upper ends from the coating-layer.

When a gemmule is examined in transverse section it appears that a long amphidiscus follows from two to six shorter ones; sometimes two or three longer ones stand close together, but they are always surrounded on all sides with shorter ones. From this we must conclude that from one to three longer

* The sponge-body itself is generally understood under the term "parenchyma," and hence the name "coating-layer" (*Belegschicht*) seems to me to be better and more suitable. The "coating-layer" contains all sorts of "coating-corpuscles" (such as coating-spicules, amphidisci, &c.) which serve for the covering (*Belegung*) of the gemmule; and, further, the term "coating-spicules" (*Belegnadeln*) has been generally adopted.

† By the ignition of the amphidisci the organic contents of the interior canal become carbonized, and thus the otherwise invisible longitudinal canal of the shaft comes distinctly into view.

amphidisci are always surrounded by a whole group of the shorter ones. The larger (longer) amphidisci are irregularly scattered among the shorter ones.

The Intermediate Structure

consists of round non-nucleate cells of very different sizes, which, without losing their rounded (spherical) form, lie quite close together, and completely fill up the spaces between the amphidisci. The diameter of the cells varies between 0·002 and 0·004 millim. The larger cells are irregularly scattered among the smaller ones, by which the structure acquires a very peculiar aspect. The intermediate structure, like the shorter amphidisci, is covered by the outer membrane.

The Outer Membrane (Oberhäutchen)

is a structureless chitinized membrane 0·002 millim. thick, which constitutes the outer covering of the whole coating-layer, and passes over the shorter amphidisci enclosed in the latter.

If we briefly sum up what has been said upon the coating-layer, it appears that it is formed of two kinds of amphidisci, both the shorter and the longer of which stand close together and are imbedded in a cellular substance, which is covered externally by a thin membrane, so that only the longer amphidisci protrude from the latter.

The coating-layer forms an umbiliciform depression from which the pore-tube projects.

3. The Pore

shows two different parts:—1. *The pore-tube*; and 2. *The pore-appendage.*

A cylindrical tube, 0·080 millim. long and 0·028 millim. wide, the walls of which diminish in thickness from below upwards, originates directly from the capsule. This tube is the pore-tube, which has the *upper* pore-opening at its upper somewhat narrowed end, and at the base a septum, which is somewhat convex downwards (inwards). The septum originates directly from the wall of the pore-tube, and cuts off the lumen of the tube from that of the gemmule itself.

4. The Pore-appendage ("cirrous appendages" of Carter).

At the upper end of the pore-tube and about 0·020 millim. below its upper opening, there springs from the wall of the pore a quadrangular, thin, pale yellowish horn-coloured lamella, 0·036 millim. broad, which forms the pore-appendage. At its four corners the lamella is produced into tags (*Zipfel*). These tags, from three to five in number, are not only of different length and thickness, but also variable in form. In some specimens they all terminate acutely and are either simple or bifid at the end; in others, on the contrary, they are curved into a sickle-shape at the ends.

Among the numerous preparations examined I have met with only two gemmules in which the pore possessed no appendage and in which the walls of the pore were entirely uninjured.

The pore-appendage has hitherto been observed only in the American species *. The sponge now under consideration is therefore the first European *Spongilla* in which this organ has been observed.

The pore-appendage is evidently locomotory in its significance. How very differently constructed the apparatus serving for locomotion may be has been shown by H. J. Carter (*loc. cit.*). We also find a very peculiar locomotory arrangement in *Trochospongilla erinaceus*, Ehrenberg, which has been recently discovered and described by Prof. Vejdovsky †.

Vejdovsky regards the cell-structure and even the pore in *Spongilla sibirica*, mihi, as an analogous locomotory arrangement. Evidence in favour of this assertion will shortly be published.

5. The Germinal Matter (Vejdovsky's "Keimkörper").

The gemmule is completely filled with a cellular substance. This substance can be observed in its natural form and condition only in quite fresh sponges, otherwise it appears in a somewhat altered state.

If we prepare a transverse section of the gemmule from a dried or spirit specimen, we find that its whole cavity is filled with numerous round or elliptical corpuscles. The largest of these corpuscles hardly attain 0·002 millim. in diameter; they are usually smaller, and sometimes even too small to be measured. All these corpuscles are loosely scattered, and always occupy the whole field. The corpuscles are distinctly contoured, but show no distinctly limited nucleus, although

* See H. J. Carter, "On *Spongiophora Pottsi*," in Ann. & Mag. Nat. Hist. November 1881; and "Form and Nature of the Cirrous Appendages on the Statoblasts, &c.," *ibid.* May 1882.

† F. Vejdovsky, 'Příspěvky k známostem o houbach sladkovodních,' Praha, 1883, figs. 3–6; H. J. Carter, Ann. & Mag. Nat. Hist. February 1884, pl. vi. figs. 3–6.

they appear darker in the middle than at the periphery, *i. e.* they are more strongly refractive at the periphery than in the middle. In general they are not unlike blood-corpuscles *.

In the gemmules (of other *Spongillæ*) investigated by me in the fresh state I have found the corpuscles in question enclosed within a spherical cell. A precisely analogous occurrence is figured by Prof. Vejdovsky †. In his figure ‡ we see the cells filled with elliptical corpuscles alone; the round nucleus which he has represented in his fig. 2 is here not to be seen. I have also been unable to find the nucleus.

We still possess very few statements with regard to the contents of the gemmules, which, however, seem to merit the attention of naturalists. The whole contents of the gemmule are enveloped by a very thin membrane, which at the same time lines the inner surface of the gemmula-capsule. In the upper part, *i. e.* at the bottom of the pore, the germinal matter forms a small conical elevation ("mamiliform projection" of Carter §) which extends as far as the septum of the pore ||.

XXXI.—*Triassic Insects from the Rocky Mountains.* By Samuel H. Scudder ¶.

Early in 1882 Mr. Arthur Lakes, Professor in the Colorado School of Mines, discovered a bed of plants and insects near Fairplay, Colorado, in rocks much older than any that have before yielded insect-remains west of the Great Plains; the two or three specimens he sent me were sufficient to prompt a more thorough exploration of the locality, which I was able to make the following summer, resulting in the discovery of a fauna and a flora of considerable interest.

The plants have been studied by Mr. Lesquereux **, who pronounces the species—some thirty in number, but in a very

* See F. Leydig, 'Lehrbuch der Histologie d. Menschen und d. Thiere,' Frankfort, 1857, p. 449, fig. 221 b.

† 'Süsswasser-Schwämme Böhmens.'

‡ Příspěvky, &c., fig. 5 *d.* And see 'Annals,' *l. c.*

§ Ann. & Mag. Nat. Hist. May 1882, p. 396, fig. 10, *e*, *h*.

|| *Loc. cit.* fig. 5, *a*.

¶ From the 'American Journal of Science' for September 1884, pp. 199–203.

** "On some Specimens of Permian Fossil Plants from Colorado," Bull. Mus. Comp. Zool. vii. p. 243.

fragmentary condition—to belong to Permian types, and declares the evidence to be decisive on this point.

The animal remains consist almost exclusively of insects, and are two thirds as abundant in species as the plants—an exceptionally large ratio in beds where both occur. These insects form an assemblage wholly different from anything before known, and, in contradiction to what Mr. Lesquereux says of the plants, clearly belong to types of a more modern character than any the Palæozoic series has yet disclosed. It is not often that one may speak so positively in the discussion of fossil insects, especially when not a single one of the species and only the smaller portion of the genera found have been previously known. But in this case all but two or three of the specimens obtained (some eighty in number) belong to a group which of all Palæozoic insects has received the most attention, namely the cockroaches. This great preponderance of cockroaches, and the fact that the few known genera found in this collection have hitherto been discovered only in Carboniferous and Permian rocks, would lead us at first to refer the beds in which they occur to one of the Palæozoic series; but the presence of the other forms, and even the characteristics of those which are referable to Carboniferous and Permian genera, unmistakably point to a later horizon.

Palæozoic cockroaches are distinguished from living types by the complete interdependence of two of the veins of the front wing, and by the fact that the anal veins of the same wings invariably impinge upon the inner margin, and never, as in existing forms, upon the anal furrow. For these ancient types the name of Palæoblattariæ has been proposed, and all Palæozoic cockroaches whose front wings are preserved (and we know them almost exclusively from these organs) fall into this group. So far as I can discover there is not a single exception to this difference between ancient and modern types. Since this was first stated five years ago the number of Palæozoic species has been increased 25 per cent., and it is still true.

In the paper in which these points were first discussed no allusion was made to Mesozoic cockroaches, as none had been found in this country, and the illustrations we possess of the European species are in many cases by no means sufficient to expose their structure; their study was therefore left until the imperfection could be remedied. It was, however, recognized, though not stated, that Palæoblattariæ exist in Jurassic rocks; it is shown, for instance, by figures of Wealden species on the fifth page of Brodie's work 'On the

Fossil Insects of the Secondary Rocks of England' (London, 1845), and by Dr. Eugen Geinitz, in his recent paper on the Dobbertin insects *, in which one species is figured from the lower Jura; but the great mass of Jurassic species are plainly more closely related to living forms, and neither in the independent existence of the veins which are characteristically distinct in Palæozoic types, nor in the course of the anal nervules, do they show any affinity to the Palæoblattariæ.

Eleven of the seventeen species of cockroaches, and five of the nine genera found at Fairplay belong to the Palæoblattariæ. These five genera are the following:—*Etoblattina* (1 species), *Petrablattina* (2 species), *Anthracoblattina*, very doubtful, the specimen being very imperfect (1 species), *Spiloblattina*, nov. gen. (4 species), and *Poroblattina*, nov. gen. (3 species). Only four of the eleven species therefore belong to known genera, and one of these is doubtful; but the difference is more marked than this, for the species referred to *Etoblattina* is an aberrant form with an excessively long internomedian vein, and both the species of *Petrablattina* agree in differing from those heretofore known to a very considerable degree. Of the new genera *Spiloblattina* is very peculiar in the strongly divergent and then convergent curve of the externomedian and internomedian veins around a large stigma near the middle of the wing, unknown in any other cockroach, ancient or modern, so far as I know; but otherwise it is related to *Etoblattina*, while *Poroblattina* is more nearly related to *Petrablattina*, and especially to the two new species of that genus from this locality.

The average size of these Fairplay Palæoblattariæ is much less than that of the Palæozoic Palæoblattariæ in general. The average length of the front wings of the Palæozoic species is 26 millim.; that of these Fairplay Palæoblattariæ 16 millim. This fact has its value, for the Jurassic species are nearly all of very small size, and the wing-length of the remaining species from Fairplay (*i. e.* those which do not belong to the Palæoblattariæ) is less than 8·5, ranging from 6·5 to 11·5 millim. This agrees completely with the size of Mesozoic species already known. The average of all the Fairplay cockroaches is less than 13·5 millim.

As to the six cockroaches from Fairplay which do not belong to the Palæoblattariæ, the characteristics of their venation as well as their small size show them to be closely allied to Jurassic forms, although the three or four genera to

* Zeitschr. deutsch. geol. Gesellsch. 1880, p. 510.

which they belong are distinct from any yet characterized. Two of them are distinctly allied to *Rithma*, a genus established rather loosely by Giebel for some species from the English Purbecks figured by Westwood. They all have a decided Mesozoic aspect, and would at once be considered Liassic, or at least Jurassic, by any one familiar with the forms already known from those deposits. They have, on the other hand, an entirely different aspect from any and all Palæozoic forms, and present no points of close comparison with any Palæoblattariæ, excepting some of those mentioned above from the same Fairplay beds, notably with the genus mentioned under the name of *Poroblattina*, which one of the genera not a little resembles.

This resemblance is of special interest because it points out the method in which the change from Palæozoic to Mesozoic forms has taken place, and does not bear out the suggestion made in my memoir on Palæozoic cockroaches (based on a comparison of the venation of the front and hind wings of existing cockroaches), that the scapular and externomedian were the two veins which were amalgamated in the historical development of the group. For when we compare the series of genera near the boundary line of the departure of the Palæoblattariæ towards later forms (those Palæozoic cockroaches allied to *Petrablattina*), and especially those brought to light by the discoveries at Fairplay, we find that, in the Mesozoic species at least, it is the mediastinal and not the externomedian vein which has blended with the scapular, although the externomedian also may become blended with the others in living types. This amalgamation has proceeded by the enlargement of the scapular area, which has crowded the mediastinal towards the base of the wing, whose few remaining branches finally become attached to the scapular vein, no trace of their former dependence remaining visible.

We have then at Fairplay an assemblage of forms altogether different from anything hitherto found in the Palæozoic series on the one hand, or in the Jurassic beds on the other. They show a commingling of strictly Jurassic forms with a larger proportion of types which may be called Upper Carboniferous or Permian with a distinct Jurassic leaning. There is therefore a strong probability that the beds in which they occur belong to the intermediate formation, the Triassic.

If this should be proved, Mr. Lake's discovery will have an added interest, from the fact that almost nothing is known either of the plants or of the insects of this formation. Of the plants, it is only necessary to point out that in the paucity of data, the Upper Palæozoic aspect of the few vegetable remains from Playfair can have but a negative value beside the positive proof of the alliance of the insects to Mesozoic forms. Of Triassic insects our knowledge is exceedingly meagre; a single neuropterous larva from the Connecticut valley is all that the formation has hitherto yielded in this country. In Europe we know of only four species, each, I believe, from a single specimen; one of these is a cockroach, but it is entirely different from any of the Fairplay species, and indeed from any other known forms, so that we get no light from this quarter.

It may be urged that, as much the larger proportion of known Palæozoic cockroaches come from Europe, our own fauna being comparatively unworked, this discovery may only indicate for America an earlier advance within Palæozoic times toward later types. Besides the important consideration that this would be in direct opposition to what we know of subsequent periods in America, there are only two facts known to me among fossil insects bearing upon this point, one in favour of this hypothesis, the other against it. The first is the recent discovery in beds at Kansas City, Mo., said by the State geologists to have 800 feet of Carboniferous rocks above them, of the wing of a heteropterous Hemipteron, which I have called *Phthanocoris*. In Europe no instance is recorded of any insect belonging to this great group of Hemiptera in Palæozoic rocks, the three or four Hemiptera so far found belonging to the homopterous division. The other fact is brought forward in my memoir on Palæozoic cockroaches, and is of far more importance, not only because it is of broader significance, but also because it is drawn from the same group as that under discussion. The Palæoblattariæ are divisible into two groups, the Mylacridæ and the Blattinariæ, the former of which is in point of structure the more primitive type. Now the Mylacridæ occur only in America, and form indeed about two thirds of the species known from this continent. In Carboniferous times, therefore, as regards cockroaches, America was *more* old-fashioned than Europe, and we should look for the introduction of new elements earlier in Europe than in America; yet the better explored Carboniferous and Permian deposits of that continent have yielded no traces of anything akin to the Fairplay insects. The first appearance of any such is in Mesozoic strata, and notably in the Lias.

So far as I know this is the first attempt to determine the age of a deposit from its insect-remains alone, and it is unfortunate for its acceptance by naturalists that the plants give it, to say the least, no support, but rather are deemed by one competent to judge to be decidedly adverse to what is here claimed.

The palæontological contradiction shown in the plants and animals of the Fairplay beds is not unknown to American geology, as every one is aware; but I do not know that it has been pointed out in this country at this horizon or in this direction—the discordance appearing later in time and the plants indicating a younger and not an earlier age than the animals. An exactly parallel case appears to be shown in Eastern Russia, for in discussing the poorer strata of Kargalinsk, which he refers to the Permian, Twelvetrees says, "As regards the flora [eleven species] the list has a Palæozoic aspect, but a Secondary one as respects the reptilian remains" [four species cited]*.

Exploration of the locality will continue, and it is hoped that future material may throw more light upon the question. It may, however, be added that the few other insects found appear to have no Palæozoic relations whatever.

XXXII.—*On the Affinities of the* Onchidia. By Dr. R. Bergh†.

The remarkable group of marine or amphibious Ichnopod Mollusca which has long been known under the name of *Onchidium* has often given rise to scientific controversies, which of late years have also had relation to the affinities of these animals, and consequently to their position in the system.

In their external characters these animals strongly resemble the Doridæ; like these they are also marine or amphibious, and they belong, like the Doridæ, chiefly to the Indo-Pacific marine regions. When closely examined as to *their internal structure*, however, the *Onchidia*, notwithstanding the "opisthobranchiate" position of the heart, prove to be very different from the Doridæ, and rather agree with the Pulmonata, even to the extent of being furnished with lungs. For this reason, although Blainville placed the *Onchidia* (*Peronia*) near the Doridæ in the group Nudibranchiata, most investigators and systematists since Cuvier and Férussac have referred them to the Pulmonata.

Very recently, as already mentioned, a very interesting

* Quart. Journ. Geol. Soc. Lond. xxxviii. p. 495.

† Translated from the 'Morphologisches Jahrbuch,' Band x. pp. 172-181.

controversy as to the systematic position of these animals has broken out. H. von Ihering, as is well known, has adopted a former notion of Milne-Edwards (1857), and has endeavoured to demonstrate that the so-called lung of the *Onchidia* in its principal mass morphologically represents the dilated terminal section of the kidney of other marine Ichnopoda, or a cloaca. According to Ihering, therefore, the *Onchidia* would be the lowest forms, the stem-forms, of his so-called "Nephropneusta" (stylommatophorous Pulmonata), and should perhaps be incorporated with the order Pulmonata; but they come near to the marine naked Mollusca*, and from these (especially perhaps the Phanerobranchia) the *Onchidia* should be derived.

There is, however, much to be urged against this theory of Ihering's, as has, indeed, already partly been done by Semper†. Semper's objections are directed principally against Ihering's derivation of the lung of the "Nephropneusta" from a terminal section of the kidney of the Phanerobranchia, and he demonstrates that the walls of the pulmonary cavity of the *Onchidia* contain no urinary concretions, and consequently cannot belong to the kidney, which, on the contrary, is enclosed by the lung. This kidney also consists of the two typical sections, the true kidney with the urine-chamber and the urinary duct; close by there is a pulmonary cavity, which, consequently, cannot represent the terminal section of the kidney. The lung, according to Semper, has not originated from the kidney of the Phanerobranchia, but is (as in the other Stylommatophora) a branchial cavity adapted for aerial respiration, which has been developed from the branchial lung of the Basommatophora. In the characters of the generative organs of the *Onchidia*, moreover, he finds a confirmation of his conception of the affinities of these animals, which he regards as Pulmonata.

To the derivation of naked Pulmonata (such as the *Onchidia*) from shell-bearing forms there is, on the whole, nothing to be objected, especially within this group. So many transitional forms occur here, from animals with a large external shell which can contain the whole animal, to those with a rudimentary shell which cannot conceal the animal (*Testacella*), and, further, to those with the shell

* H. von Ihering, 'Ueber die systematische Stellung von *Peronia*,' 1877, p. 30. See also 'Anatomie des Nervensystems und Phylogenie der Mollusken,' 1877, p. 223:—"We might perhaps with equal justice refer them to the Phanerobranchia as to the Nephropneusta."

† Semper, "Einige Bemerkungen über die Nephropneusten, v. Ihering," in Arb. zoolog. zoot. Institut in Würzburg, iii. 1877, pp. 480–488.

small and half-concealed (*Parmacella*) or quite internal (*Limax*). Even within the different groups of the Stylommatophora naked and shelled forms occur side by side, as *Limax* and *Vitrina*, *Arion* and *Helix* *. And now, since a shell has been demonstrated in the larva of *Onchidium*, that difficulty no longer exists.

Thus, in a monographic memoir by Joyeux-Laffuie †, the developmental history has recently been described, not indeed of a typical *Onchidium*, but of *Onchidium celticum*. From the author's description it appears clearly that the animal, as a larva, possesses a shell, which is afterwards cast off. As regards the other anatomical characters of the animal, Joyeux-Laffuie especially points out that *Onchidium* "possesses no organ representing the pulmonary or branchial cavity;" the so-called lung is only the cavity of the true kidney, the vascular system of which is also inserted into the venous circulation in the manner characteristic of the Mollusca generally; but nevertheless the organ does function as a lung ‡. At the same time, however, he represents as the most essential the respiration by means of the papillæ of the skin (which are branched in many *Onchidia* [*Peronia*]), and has also demonstrated in them a strong vascular development § (as already asserted by Ihering in opposition to Semper); and, moreover, he has experimentally proved the predominant importance of this cutaneous or branchial respiration ‖. Joyeux-Laffuie further indicates the agreement of the *Onchidia* and the Pulmonata in the structure of the nervous system and of the digestive organs, and on the whole regards the *Onchidia* as "marine branchiferous Mollusca with a tendency towards pulmonary respiration and a terrestrial existence." It is therefore essentially rather upon physiological than morphological grounds that the author nevertheless places the animals with the Pulmonata, at the same time referring to Forel's well-known observations upon the *Lymnææ* of the Lake of Geneva (*L. abyssicola*).

Of Joyeux-Laffuie's monograph Brock ¶ has given a detailed report, to which he has appended a critical examination, through which, however, he comes to quite other conclusions than those of the French author. According to him

* H. von Ihering, *loc. cit.* p. 33.

† Joyeux-Laffuie, "Organisation et développement de l'Oncidie," Thesis in Paris, 1882, pp. 1–159, and Arch. de Zool. expér. et génér. x. (1882) pp. 225–383, pls. xiv.–xxii.

‡ *Loc. cit.* p. 148 (372).

§ *Loc. cit.* p. 53 (277), pl. xv. fig. 4.

‖ *Loc. cit.* p. 56 (280).

¶ J. Brock, in Biol. Centralbl. iii. 12, 1883, pp. 370–374.

the resemblance in the structure of the nervous system and reproductive organs which the *Onchidia* present especially to the basommatophorous Pulmonata is of quite a superficial nature; while he also ascribes no importance to various other anatomical characters of the *Onchidia* which also occur in the Pulmonata, either because they (such as the position of the seminal duct) occur "only" in atypical Pulmonata (*Vaginulus*), or because they (such as the position of the typical eyes) have originated in another way than in the Pulmonata *. With regard to the kidney, Brock is of opinion that "wherever we may begin with the phylogeny of the Pulmonata, the kidney of the *Onchidia* is a true kidney, and only in its adaptation to aerial respiration engaged in a change of function, which, even if we regard the organ as in course of becoming a lung, certainly has nothing to do with the analogous adaptive phenomenon in the Pulmonata." With regard to the affinities of these animals, however, the developmental processes as displayed by Joyeux-Laffuie seem to him to be quite decisive. Unfortunately this ontogeny, which is so interesting on its own account, has for the moment the less interest, because the *tertium comparationis*, or complete developmental history, embracing the first stages, of one of the so-called Nudibranchiata, is, so to speak, completely wanting. Here, however, the strong development of the velum in the larvæ of *Onchidium* must on no account lead us to hasty conclusions; Semper † has already stated that the larvæ of "different species of the genera *Auricula* and *Scarabus*, which belong to the Pulmonata, bear opercula;" and in the (still unpublished) sketches of the larvæ which Semper has sent to me the larva bears a large velum, exactly like the *Onchidium*-larva, to which ‡ Semper's figures present a great resemblance §. The Pulmonate nature of *Scarabus* can, however, hardly be doubted ‖. Ihering is certainly, at least for the present, partially justified in expressing himself ¶ against the over-estimation of ontogeny in the interpretation of phylogenetic relations and in classification, and, in opposition to both Häckel and Semper, placing comparative anatomy in the foreground in the discussion of such questions. From his whole revision of the above-mentioned work Brock concludes that *Onchidium* is "a Nudibranchiate,

* Brock, *loc. cit.* p. 372.

† Semper, 'Die natürlichen Existenzbedingungen der Thiere,' 1880, ii. p. 101. English edition, p. 282.

‡ See Joyeux-Laffuie, *l. c.* pl. xx. figs. 8, 9, pl. xxi. figs. 1–3.

§ See also Ihering, Vergl. Anat. d. Nervensyst. 1877, pp. 203, 221.

‖ Semper, *loc. cit.* i. 1880, p. 238.

¶ Ihering, 'Ueber die syst. Stellung von *Peronia*,' 1877, pp. 37, 38.

perhaps aberrant in certain points," and in process of becoming an air-breather *.

Against this conception of *Onchidium* as a Nudibranchiate, comparative anatomy must, I think, enter an absolute protest. From the outwardly superficially similar Doridæ these animals are very widely separated; and, indeed, there is no single group of that order, rich as it is in forms, to which the *Onchidia* closely approach, or from which they could naturally be derived, not even the Ascoglossa, with their varying nervous systems. An alliance with, or derivation from, the Steganobranchiata (Tectibranchiata) would certainly be much more possible. *Comparative anatomy, however, must quite decidedly claim the* Onchidia *as Pulmonata.* The examination of a large new *Onchidium* (*O. melanopneumon*, Bgh.) from the Pacific (Fiji Islands), brought home by the 'Challenger' expedition, as well as that of other *Onchidia* (*O. tonganum*, Q. & G., *O. verruculatum*, Cuv.), has taught me nothing else †.

The *central nervous system* of the *Onchidia* agrees with none of the types occurring in the Nudibranchiata, at any rate there is only a superficial resemblance to the Ascoglossa, which are otherwise so distant (and derived from the Steganobranchiata). It is almost unintelligible how Ihering could see here "exactly the same type of the nervous system that is displayed by the Æolidiæ and Doridæ." On the contrary, *the nervous system of the* Peroniæ *does not differ essentially from that of the Pulmonata.* In the latter, as is well known, it consists of two superior cerebral ganglia, two inferior pedal ganglia, and several (up to 5 or 6) ganglia placed more or less unsymmetrically below the latter, and belonging chiefly to the visceral nervous system. The nervous system of the *Onchidia* is also of this kind, only with the lowermost part more condensed and reduced.

The central nervous system ‡ of *Onchidium tonganum* appears, when still enclosed in its sheath, as a broad ring, of which the upper and lower arches are strongly flattened;

* Brock, *loc. cit.* p. 372.

† R. Bergh, "Report on the Nudibranchiata," in Reports on the Scientific Results of the Exploring Expedition of H.M.S. 'Challenger,' &c., vol. ix. 1884, pp. 126–150, pl. iv. figs. 25–27, pl. v. figs. 1–27, pl. vi. figs. 5–21, pl. vii. figs. 1–12, and pl. viii. fig. 14.

‡ From want of material I was unable accurately to define the central nervous system of the *Onchidia* formerly investigated by me (*loc. cit.* pp. 130, 141, 147), and the preceding investigations (see Ihering, *l. c.* p. 230, Taf. iv. fig. 16) are scarcely of any use. I have therefore resumed this investigation upon two large specimens of *O. tonganum*, Q. & G., from the Nicobars. The relations of the ganglia were perfectly in accordance in both individuals.

where these arches meet together there occurs a strong thickening (cerebral ganglion), and the inferior arch, which is the further back, is thicker than the upper one, and penetrated by a strong extramedian (right) artery. It is very difficult to prepare the nervous system, which appears in all parts yellow or brownish yellow, out of the whitish firmly adherent sheath, which is continued to a considerable distance around the thicker nerves. The ganglia are all coarsely nodular, the nodules projecting strongly at the surface, sometimes pedunculate. *Cerebral ganglia* of rounded triangular form, somewhat flattened. The intercerebral commissure thin, sometimes scarcely occupying one sixth of the breadth of the superior ring, longer than the transverse diameter of the ganglion. The left cerebro-pedal connection is very short, the right one much longer. The left *pedal ganglion* is larger than the right one, which is submedian in position; both flattened, of oval form, giving off three or four strong *nervi pediaci*; the pedal commissure short*. Behind and beneath the preceding ganglia lie the three *visceral ganglia* quite unsymmetrically. The largest and rather thick right one is united almost directly by a very short cerebro-visceral connective with the cerebral ganglion, and by a viscero-pedal connective, which unites with the cerebro-pedal connective, with the right pedal ganglion. The *right* visceral ganglion is united by a short commissure with the *median* (genital) ganglion, which is also situated to the right, and it is also connected with the left ganglion by a long and powerful commissure; behind the last-mentioned commissure lies the much thinner subcerebral commissure, which may be traced into the cerebral ganglia. The *left* visceral ganglion is more depressed than the others, and is connected with the cerebral ganglion by a tolerably long connective, and with the pedal ganglia by a somewhat shorter one. As in the Pulmonata, so also here the *gastro-œsophageal ganglia* which always occur in the Dorididæ (perhaps with the exception of many *Polycerata*†) *are deficient*.

The *ophthalmophores* of the *Onchidia* are like those of the stylommatophorous Pulmonata, and such as occur elsewhere in no Gasteropoda. If it should really be the case, as Joyeux-Laffuie states (*l. c.* p. 141 [365]), that the *eye* here is first of all formed on the head, and only ascends afterwards with the ophthalmophore, while in the Stylommatophora it is deve-

* A doubling of this commissure, such as is described by Joyeux-Laffuie in *O. celticum* (*l. c.* p. 79 (303), pl. xvii. fig. 4 *a*, *b*), does not occur in this case.

† See R. Bergh, "Beiträge zur Kenntniss der Polyceraden III.," in Verhandl. k.-k. zool.-bot. Ges. in Wien, Bd. xxxiii. (1883), p. 157.

loped later by invagination upon the already-formed ophthalmophore (Eisig, Fol), it is certainly not of the importance which Brock would attach to this circumstance.

The relations of the *pedal gland* in the *Onchidia* are very much as in the Stylommatophora. While in some species (*O. tumidum*, Semper) this gland remains entirely, or for the most part, enclosed in the foot, as in *Philomycus**, in most it projects with its posterior part more or less into the body-cavity†. The gland is much more strongly developed and freer in position in *Limax marginatus*, Drap.‡, in *Janella*§, and *Limax pectinatus*‖, but especially in *Triboniophorus*¶.

The *digestive system* of the *Onchidia* (including the liver) shows hardly any important difference from that of the Stylommatophora.

The *Onchidia* are certainly "Opisthobranchiate," but so also are the *Veronicellæ*, nay even *Arion* and *Limax***, all of which, however, are undoubted Pulmonata. This *position of the heart* is consequently here of no systematic significance, especially as there are Opisthobranchiata which are prosobranchiate (*Acera*, *Gasteropteron*).

The *kidney* of the *Onchidia* is parenchymatous, which is never the case in the Nudibranchs; it is for the most part enclosed by the substance of the lung, or at least reaches the wall of the pulmonary cavity only at a few points. Its character again is essentially as in the Pulmonata, only the neighbouring *pulmonary cavity* is much smaller because the respiration is to a great extent cutaneous. Joyeux-Laffuie denies to *O. celticum* any real lung-substance, and represents the organ in question as consisting exclusively of renal tissue; but this assertion is scarcely correct, and will hardly be confirmed by later investigations. The organ of communication between the pericardium and the renal cavity ("Nierenspritze" of Bergh), which always occurs in the Nudibranchiata, has been of late years recognized by Semper†† and

* R. Bergh, "Untersuchungen des *Triboniophorus Schüttei*, K.," Verhandl. k.-k. zool.-bot. Ges. in Wien, Bd. xx. (1870), pp. 860, 865.

† Keferstein, "Zur Anatomie von *Philomycus carolinensis*," Zeitschr. f. wiss. Zool. Bd. xvi. (1866), p. 187, pl. ix. fig. 2, *gp.*; R. Bergh, 'Challenger' Expedition, *l. c.* pl. vii. fig. 1.

‡ Zeitschr. f. wiss. Zool. Bd. viii. (1857), p. 351 (Semper).

§ Keferstein, "Ueber die Anatomie der *Janella bitentaculata*," Zeitschr. f. wiss. Zool. Bd. xv. (1865), p. 449, pl. xxxiv. fig. 3, *gp.*

‖ Malakolog. Blätter, 1865, p. 107, pl. ii. fig. 3, *gp.*

¶ Keferstein, "Ueber die zweitentakeligen Landschnecken," Zeitschr. f. wiss. Zool. Bd. xv. (1864), p. 84, pl. vi. fig. 4, *gp.*; Bergh, *l. c.* (1870), p. 850.

** See Ihering, 'Nervensystem,' &c. 1877, p. 226.

†† Semper, *l. c.* (1877), p. 485, note 1.

Nüsslin* in various Pulmonata. The absence of this organ in *Onchidium*, asserted by Joyeux-Laffuie and Brock, is also incorrect, seeing that I have ascertained its existence in *O. tumidum*, Semp.†. The very fine aperture in the pericardium occurs beneath the bottom of the auricle, a little to the left side. At the hindmost part of the upper wall of the pulmonary cavity there is the fine *renal pore*; it leads into a *urine-chamber*, at first narrow and afterwards wider, which extends, rather superficially, through the whole length of the kidney, bending with that organ. *The lung is therefore not a dilated terminal section of the kidney*, and this the more because the structure of the kidney and that of the wall of the lung are quite different.

The relationship of the *Onchidia* to the Pulmonata appears with special distinctness in the structure of the *generative system*. What strikes one here above all is the *position of the seminal duct* in the lateral wall of the body. A similar condition occurs in no Nudibranch, and has indeed only been demonstrated in the Pulmonata. In the *Veronicellæ* (*Vaginulæ*) the position of the seminal duct is the same, only the portion of the duct enclosed in the musculature of the body is shorter, because here the vulva is removed more forwards to the middle of the length of the body. In the Auriculaceæ and Lymnææ the same anatomical relation again makes its appearance, but the enclosed portion of the duct has become still shorter. Ihering's attempt‡ to homologize the ciliated groove of the *Onchidia* with that of the Steganobranchiata, and to interpret the seminal duct of the former as only a vessel constricted off from the bottom of the ciliated groove, is hardly a very happy one.

Consequently, then, *the Onchidia agree with the Pulmonata* in the structure of the *nervous system*, in the existence of a *lung* and of a *parenchymatous kidney*, in the presence of the peculiar *pedal gland*, and in various peculiarities of the *generative system*. From a tolerably extensive knowledge of the so-called Nudibranchs I cannot but regard the *Onchidia* as pretty widely separated from them. On the contrary they branch off from the Pulmonata; *they are Pulmonata which have adapted themselves to an amphibiotic or marine mode of life*.

* O. Nüsslin, "Beiträge zur Anatomie und Physiologie der Pulmonaten," 1879, pp. 14, 15, fig. 3.

† R. Bergh, 'Challenger' Expedition, *l. c.* p. 137, note 2.

‡ H. von Ihering, 'Ueber die systematische Stellung von *Peronia*,' 1877, p. 29.

XXXIII.—*On a new Species of the Theclid Genus* Theritas *from Colombia*. By ARTHUR G. BUTLER, F.L.S., F.Z.S., &c.

THE following species was brought to the Museum for identification by Mr. and Mrs. Alfred E. Oakes, by whom it has been generously presented to the National Collection. I therefore propose to give it the name of *T. Oakesii.*

Theritas Oakesii, sp. n.

Allied to *T. ducalis* and *T. actæon*, but markedly different from both. Primaries above with the basi-internal half greenish *Morpho*-blue ; externo-costal half velvety blue-black ; fringe slaty grey : secondaries of the same blue as the basal half of primaries, but golden green at anal angle ; abdominal border lilacine grey ; external margin and costa rather broadly bordered with black from near the base of costal margin to the second median branch, at which point the inner tail is emitted ; the outer or anal tail is emitted from a prolongation of the wing between the first median and submedian veins, and is fully one third longer than the inner tail ; both are black and continuous with a well-defined black marginal line ; the fringes of the outer margin and tails steel-blue. Head above golden, the antennæ and distal half of palpi black, front margin of thorax opaline ; remainder of body bright morpho-blue. Primaries below lilacine grey, the apical and costal areas densely irrorated with golden-green scales upon a dark brown ground ; a narrow black marginal line ; fringe steel-grey : secondaries golden green at base and towards internal and external margins, becoming almost cupreous on the disk, this colour passing gradually into purplish rose over the sub-basal area from the end of the cell almost to the base itself ; tails, marginal line, and fringe as above ; two subparallel black stripes above the anal angle, the upper ones curving inwards to the abdominal border, the lower angulated, bordering the anal sinus and continuous with the outer tail ; the remainder of the wing, excepting at outer margin, covered with short, thick, black strigæ : legs black and opaline. Expanse of wings 40 millim.

Caught at the village of Malpaso (Tolima) in Colombia, South America.

XXXIV.—*Some Phenomena in the Life-history of* Clathrulina elegans. By SARA GWENDOLEN FOULKE *.

WHILE collecting Infusoria among *Lemna* and the leaves of the yellow pond-lily, in a ditch on Brandywine Creek, Chester County, Pennsylvania, the writer was so fortunate as to secure large numbers of that beautiful Heliozoan, *Clathrulina elegans.*

This rhizopod was attached in myriads to the roots of the *Lemna*, the groups in many cases being composed of above twenty-five colony-stocks, so matted together by the twisting of the pedicels and so surrounded by waste matter as completely to conceal at that point the supporting root-fibre.

The animals were in a most active condition, feeding by means of their characteristic pseudopodial rays, and multiplying so freely by self-division, that the water was full of the *Actinophrys*-like bodies, and almost every capsule supported from one to ten young individuals.

After being kept in captivity for two weeks the large social groups had decreased in number, although solitary individuals were much more numerous. Reproduction was still going on, but not so freely and by more varied methods. The phenomena exhibited during the act of reproduction are the subject of this communication.

The modes of reproduction are four in number, two of these being slightly similar, while the others essentially differ in character. These four modes are :—*first*, by division ; *second*, by the instantaneous throwing off of a small mass of sarcode ; *third*, by the transformation of the body into flagellate monads ; and *fourth*, by the formation and liberation of minute germs.

By the *first* mode, and this is the most common, the sarcode-mass within the capsule withdraws its rays, constricts, and divides into from two to four granular masses, which, after a varying period of rest, pass out from the capsule and instantly shoot forth pseudopodial rays on all sides, thus assuming the appearance of an *Actinophrys sol.* These *Actinophrys*-like bodies after a time develop a protoplasmic stalk or pedicel, by which they attach themselves usually to the parent capsule. A thin film of protoplasm is then thrown out and subtended by the rays at a short distance from the body, and this, by development and secretion, becomes the latticed

* From the 'Proceedings of the Academy of Natural Sciences of Philadelphia,' January 15, 1884, pp. 17–19.

siliceous capsule. The pedicel also becomes more rigid, though always retaining a degree of flexibility. This manner of reproduction was first described by Cienkowski, the great Russian observer and discoverer of *Clathrulina elegans* (see Leidy's 'Rhizopods of North America').

In the *second* mode of reproduction the rays are not withdrawn, nor does the body divide, but the sarcode becomes finally vacuolate, presenting knob-like projections. Suddenly a small mass of sarcode, usually one of the knob-like projections, detaches itself, and, passing out of the capsule, shoots out rays and develops, though more slowly, in the manner described above. This continues until the parent body is much reduced in size, when the rays again protrude, and the animal returns to its normal condition.

The *third* mode of reproduction is by the formation and liberation of minute germs. In this state also the rays are not withdrawn, but the body of the *Clathrulina* becomes finally filled with minute green particles, which, even before liberation, exhibit active motion. A number of these are expelled, enclosed in a thin protoplasmic film or globular sac, which bursts shortly, and the liberated germs swim away. The development of these germs after this point is yet to be followed.

The *fourth* mode is still more remarkable, and is also significant in bringing to light a new phase in the life-history of the Heliozoa. The *Clathrulina* in which these phenomena were first observed withdrew its rays and divided into four parts, as in the ordinary method; but the sarcode, instead of becoming granular and of a rough surface, grew smoother and more transparent. Then followed a period of quiescence—in this case of five or six hour's duration, although in other instances lasting three days and nights; after which one of the four parts began slowly to emerge from the capsule, a second following a few moments later.

While passing through the capsule, these masses of sarcode seemed to be of a thicker consistence than the similar bodies which, in the ordinary methods, instantly assume the *Actinophrys* form. After both had passed completely through for nearly a minute they lay quiet, gradually elongating meanwhile. Then a tremor became visible at one end, and a short prolongation of the sarcode appeared waving to and fro. This elongated at the same time into a flagellum, the vibrations becoming more rapid, until at the same moment both the liberated monads darted away through the water. They were followed for about ten minutes, when both were lost to sight among a mass of sediment, and the fear of mistaking one of the common monads for them led the observer to abandon the search. Returning to the parent capsule, a third monad was found to have escaped in the meantime. After twenty-four minutes' quiescence, the fourth body in its turn approached the wall of the capsule, emerged, developed a flagellum, and swam away, a free monad. With a one-half inch objective this one was closely watched, and the following details noted:—body oval, transparent; nucleus present, dark-coloured and situated near the centre; a pulsating pink vesicle, situated posteriorly; and a flagellum slightly longer than the body.

For one hour and fifty-eight minutes the monad swam in all directions, usually in concentric, ever-widening circles, then suddenly darting off at a tangent to begin again in a new spot. At the end of this time, in its course it touched one of the free young *Clathrulinæ*, and, to prevent it being used as food by its cannibal relation, the glass cover of the live-box was tapped, so that the current produced carried the monad a short distance away, where it remained almost motionless several seconds.

By a change to a power of 350 diameters, the monad was shown to attach the top of its flagellum to the glass and revolve swiftly for a few moments, when instantly the whole body became spherical, rays were shot out, and the transformed monad was in no point, except that of size, to be distinguished from its *Actinophrys*-like cousin, whose career had been so different. In some cases the monads remained attached by the flagellum, using it as a pedicel. The whole development, from the time when the monad began its free life, occupied two hours and some seconds.

This mode of reproduction secures a more widespread distribution of the young than would be possible did this depend on the sluggish *Actinophrys* form. It seems reasonable to suppose that this is a wise provision for the perpetuation of the species, should adverse conditions of life arise; and also to prevent an undue accumulation of the animals within a circumscribed space.

The tendency of these Rhizopods to attach themselves to the parent capsule (a result of the inertness of the *Actinophrys* form of young), together with the fact that this mode of reproduction was apparently induced by a lengthened captivity (necessarily the source of adverse conditions), would point to the reasonableness of the above conclusions.

XXXV.—*On* Astylospongidæ *and* Anomocladina. By KARL A. ZITTEL*.

DR. G. J. HINDE, in his Catalogue of the Fossil Sponges in the British Museum, which will form the foundation for all future spongiological work in England, has expressed some doubt as to the systematic position of the Astylospongidæ. The doubts long since communicated to me by Dr. Hinde by letter, have induced me to make a new examination of the skeleton of *Astylospongia* and *Palæomanon*, for which I was able to make use of a considerable number of thin sections of most of the known species.

Astylospongia and *Palæomanon* in their external form, the structure of their skeleton, and their canal-system stand in a certain contrast with the Hexactinellidæ. In no typical Hexactinellid genus does the skeleton form so thick and massive a wall, in none is the root-tuft or a basal surface of adhesion wanting, and that the canal-system of *Astylospongia* almost exactly resembles that of certain Lithistidæ, I have already pointed out in my 'Studien' (Abtheilung i. p. 30; see 'Annals,' ser. 4, vol. xx. p. 412). The skeleton consists of a reticulated latticework, in which from six to nine rays issue more or less regularly from thickened nodes and attach themselves by their extremities to neighbouring crossing knots of the same nature. The skeletal meshes thus formed are sometimes triangular or quadrangular, sometimes irregularly polyhedral.

If we compare this skeleton with that of other Sponges we are struck, in the first place, with a resemblance to some Dictyonina. The irregularity of the meshes, the deviation from the rectangular position of the rays, is by no means unusual in typical Hexactinellidæ; but in such cases, even when there is great irregularity of the skeleton, the axial canals always show the sex-radiate cross. Nothing of the kind has ever been observed in *Astylospongia*.

Prof. Martin† has very carefully described the skeleton of *Astylospongia* almost simultaneously with myself, and arrived, like myself, at the result that the Silurian genus was certainly to be joined with the Hexactinellidæ, but that nevertheless considerable differences exist between *Astylospongia* and the typical Hexactinellidæ. Martin finds the most important

* Translated by W. S. Dallas, F.L.S., from a separate copy, furnished by the author, of his paper in the 'Neues Jahrbuch für Mineralogie,' &c. 1884, Bd. ii. pp. 75–80, Taf. i. & ii.

† 'Archiv des Vereins der Freunde der Naturgeschichte in Mecklenburg,' Jahrg. xxxi. (1877).

difference in the circumstance that in *Astylospongia* more than six rays generally issue from one nodal point. A positive difference between Martin's description of the skeleton of *Astylospongia* and my own relates to the nature of the "crossing nodes," which are described by me as solid and by Martin as hollow. In this 'Jahrbuch' (1877, pp. 709, 710) I have explained the occasional occurrence of hollow nodes as a consequence of the state of preservation, and I still think I must adhere to this opinion. In another point, however, Martin has completed and corrected my observations. The ramification of the ends of individual bars of the skeleton occurring in *A. pilula* I have since seen not only in the preparation kindly furnished to me by Prof. Martin, but also in sections of other species. This forking is really not the result of later actions, as I formerly thought, but evidently an original peculiarity of the skeletal elements, and, indeed, the solid nodes are produced entirely by the amalgamation of the forked extremities of from six to nine bars. Of this the excellent figure given by Hinde (*l. c.* pl. xxiii. fig. 1 *b*) leaves scarcely any doubt; but the very accurate drawings

Fig. 1.

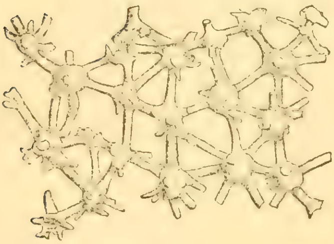


Fig. 2.

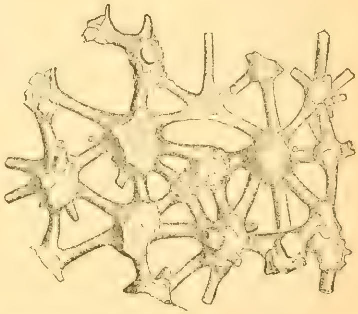


Fig. 1.—Skeleton of *Astylospongia præmorsa*, Goldf., from the Upper Silurian of North Germany.

Fig. 2.—Skeleton of *Palæomanon cratera*, F. Röm., Upper Silurian, Tennessee.

Enlarged 25 diameters.

which Mr. C. Schwager has had the kindness to prepare for me show very instructively the mode of formation of the "crossing nodes" in both *Astylospongia* (fig. 1) and *Palæomanon* (fig. 2).

Dr. Hinde thinks that he can distinguish two kinds of nodes in *Astylospongia*, some produced by the amalgamation of the slightly forked ends of the skeletal corpuscles, while the others indicate the point from which the branches belonging to a skeletal element radiate. On careful examination I have only been able to find one kind of node, and think I may assume that all of them have originated in the same way from the union of the furcate ends of several skeletal elements.

From this, however, it follows that *the latticed skeleton of the Astylospongidæ does not consist of sexradiates fused together, but of simple rods, both ends of which are branched and, by union with from six to nine other rods, form the characteristic nodes. Hence the Astylospongidæ, as they contain no sexradiates, cannot belong to the Hexactinellidæ.*

If we look round the other orders of Sponges it is only the Lithistidæ that possess skeletal corpuscles with radiciform branched ends. The external form, the dense, stony nature of the skeleton, and the complicated canal-system of the Astylospongidæ also point towards the Lithistidæ. Of the four families distinguished among the Lithistidæ, the Rhizomorina, Megamorina, and Tetracladina cannot come into consideration, as the form of their skeletal corpuscles is quite different.

Dr. Hinde has therefore very justly indicated the Anomocladina as the group with which the Astylospongidæ can best be compared. The typical genera here are *Melonella*, *Cylindrophyma*, and *Mastosia*; with the first *Astylospongia* almost exactly agrees in its canal-system.

The investigation of the Anomocladina formerly offered me greater difficulties than that of the other Lithistidæ. Thus it is very seldom that we find well-preserved specimens fitted for microscopic examination; the skeleton is almost always converted into calc-spar or deformed by subsequent silicification. The correct figures of the skeleton of *Cylindrophyma* ('Studien,' ii. pl. v. fig. 6) show a very irregular latticework with thickened nodes, which, however, sometimes acquires a more regular appearance and then resembles the network of a Hexactinellid (see my figures, *l. c.* pl. v. fig. 6 *d* & fig. 7, as also the slightly enlarged figures in Quenstedt's 'Petrefactenkunde Deutschlands,' Schwämme, pl. cxxi. figs. 3 *x* & 4 *y*). I formerly regarded the Anomocladine skeleton as a latticework of which the elements consist of four or more smooth arms meeting together in a thickened centre and branched at their extremities.

In a short memoir upon two new genera of Sponges from the Upper Jura of Sontheim (Jahrb. f. Min. &c. 1883, ii. p. 59) Mr. G. Linck describes, under the name of *Didymosphæra*, an Anomocladine form supposed to be new, but which, according to a preparation for which I am indebted to the kindness of Dr. Steinmann, is identical with *Cylindrophyma*. Mr. Linck, however, points out some peculiarities of these skeletal corpuscles which show that my definition of the Anomocladina is not quite correct. Thus Linck's figures (*l. c.* Taf. ii. fig. 4) represent isolated skeletal corpuscles, "globularly thickened" at both ends and showing a simple axial canal. The axial canal terminates at both ends *before* the thickened inflations, and thus, as Mr. Linck justly remarks, the supposition that several branches meeting together in a node belong to one skeletal corpuscle becomes impossible. In *Cylindrophyma*, therefore, as in *Astylospongia*, the production of the nodes is to be explained as effected in this way—the thickened or, more properly, branched ends of several skeletal elements meet together and become amalgamated. The distinction between *Astylospongia* and *Palæomanon* on the one hand and *Cylindrophyma*, *Melonella*, and *Mastosia* on the other consists chiefly in the fact that in the Silurian genera the straight, rod-like skeletal elements only emit short root-like branches at their extremities, while in the Jurassic forms a stronger furcation of the ends often occurs, and sometimes larger side branches may issue from the main

Fig. 3.

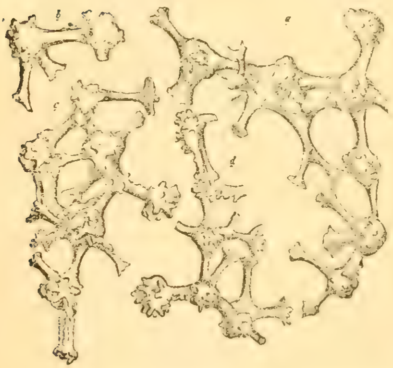


Fig. 4.

Fig. 3 *a–d*.—Skeleton of *Cylindrophyma milleporata*, Goldf., Upper Jura ε, Sontheim.

Fig. 4 *a–e*.—Skeleton of *Lecanella pateræformis*, Zitt., Upper Jura ε, Sontheim. Enlarged 25 diameters.

bar. Mr. Schwager has drawn figs. 3 *a–d* from an unusually well-preserved specimen of *Cylindrophyma* from the Upper Jura ε of Sontheim; and these show clearly the mode of production of the nodes and the construction of the skeleton, and at the same time prove the typical agreement with *Astylo-*

spongia and *Palaeomanon*. In all essential characters *Melonella* and *Mastosia* agree with *Cylindrophyma*; on the other hand, *Lecanella*, which I formerly referred to the Anomocladina, shows peculiarities which it is difficult to bring into harmony with the other forms.

In figs. 4 *a–f* I have had carefully represented some isolated skeletal corpuscles of *Lecanella* which are remarkable for their large size. These were obtained by the action of hydrochloric acid from the still unique original specimen from Sontheim. If the corroded parts of the sponge-body are examined by direct light it is seen that the skeletal elements are not firmly bound together, but that the furcate ends are only loosely applied to each other without being amalgamated. By treatment with acid, therefore, we never obtain connected parts, but only the isolated corpuscles shown in fig. 4, which evidently represent the primary elements of which the skeleton of *Lecanella* is built up. These, however, can hardly be likened to the simple rods, branched only at the ends, of the typical Anomocladina, for the enlarged nodes are here really the starting-points of 4, 5, 6, or more arms, which are slightly branched at their extremities. The genus *Lecanella* essentially influenced my former incorrect definition of the Anomocladina; if it be removed from that group we find among the Megamorina the genera *Doryderma* and *Heterostinia*, or also *Helodictyon* and *Pachypoterion* of Hinde, the skeletal elements of which show an unmistakable resemblance to those of *Lecanella*.

I therefore do not hesitate to remove *Lecanella* to the Megamorina, and the Silurian genus *Hindia*, Duncan, may also find its right place in the same group.

From the foregoing remarks it appears that, as supposed by Hinde, the Astylospongidæ do not belong to the Hexactinellidæ, but to the Lithistidæ, and, indeed, to the family Anomocladina. The definition of the latter will then have to be modified as follows:—

Family Anomocladina.

Skeletal elements consisting of simple, generally straight, but sometimes curved rods, more or less strongly branched at the two extremities. The branched ends of several (4–9) neighbouring rods meet together, and by their amalgamation form nodes. In this way is produced a latticework resembling that of certain Hexactinellidæ.

The genera belonging to this family are:—

Astylospongia, F. Römer. Silurian.
Palæomanon, F. Römer. Silurian.
Protachilleum, Zitt. Silurian.
? *Eospongia*, Billings.
Melonella, Zitt. Upper Jura.
Cylindrophyma, Zitt. Upper Jura.
Mastosia, Zitt. Upper Jura and Neocomian.
Vetulina, O. Schm. Recent.

XXXVI.—*Contributions towards a General History of the Marine Polyzoa.* By the Rev. THOMAS HINCKS, B.A., F.R.S.

[Continued from vol. xiii. p. 369.]

[Plates VIII. & IX.]

XIII. POLYZOA FROM VICTORIA (*continued*).

Family **Cellulariidæ**.

MENIPEA, Lamouroux.

Menipea marginata, n. sp. (Pl. IX. fig. 1.)

Zoarium dichotomously branched; branches stout, of considerable width, expanding upwards, with a marginal rib, formed of many tubes closely appressed to one another, which are given off from the dorsal surface. *Zoœcia* disposed in 5–7 longitudinal series, alternate, contracted above, expanded below; front wall wholly membranous (no calcareous expansion), margin thin, on the outer edge above three or four tall and stout spines, on the inner two; an operculum springing from the inner side, a short distance below the top of the cell, expanded above, bilobed, and deeply sinuated on the upper margin, placed edgeways; at the bottom of each cell, on one side or both, a small *avicularium* with triangular mandible; the marginal cells larger than the rest and bearing gigantic spines, which form a conspicuous line along the edge of the zoarium (Pl. IX. fig. 1 *b*); below each of these cells a distinct area, on which is placed a very large *avicularium* resembling in many points the articulated avicularium of *Bugula*, but sessile and fixed, the basal region well rounded, the mandibular portion turned upwards, beak strongly uncinate, mandible pointed. *Dorsal surface* flat, the cells showing as fusiform areas; between each pair of marginal zoœcia a small rising from which a chitinous tube originates, which unites with the marginal rib. *Oœcium* terminal, galeate, flattish in front, surrounded by a thickened line, somewhat elongate, rounded or subacuminate above, surface smooth.

Loc. Port Phillip Heads (*J. B. Wilson*).

In this remarkable species there are none of the lateral appendages which are so common amongst the members of the genus *Menipea*. They are replaced by the large avicularia, which are intercalated between the marginal cells and form a conspicuous line along the whole length of the branch. These are fixed and destitute of a peduncle; but the conformation of the anterior or mandibular region approaches very closely to that which we have in *Bugula*, and we cannot fail to recognize in the avicularium of the present species a transition form leading on to the articulated type. The modification of the marginal cells is another interesting peculiarity; they are very much larger than the rest and support an array of spines of corresponding size. Another character which deserves notice is the marginal rib which edges the zoarium through its entire extent, composed of the tubular fibres, which play so important a part and discharge so many functions in the economy of the Polyzoa; they are given off from a small swelling placed on the dorsal surface between the marginal zoœcia, which probably represents the vibracular or avicularian cell of other forms. This rib exists in many Polyzoa belonging to very different families and was employed by Gray as the distinctive character of his genus *Flustramorpha*, a purely artificial group.

Family **Membraniporidæ.**

Farciminaria, Busk.

Farciminaria uncinata, n. sp. (Pl. VIII. fig. 2.)

Zoarium dichotomously branched, stems and branches slender, four-sided. *Zoœcia* disposed in four longitudinal series, elongate, rounded at the top, widest above and narrowing gradually towards the base; margin thin, not much raised, usually a small acuminate spine on each side above; front wall membranous, semitransparent, more or less covered with minute disks, strongly lined transversely just below the orifice, which is at the very top of the area; on each side, immediately within the margin and extending for some way down the cell, a hollow structure, sac-like in form, supporting towards its upper extremity a strongly pointed uncinate process (or spine) which projects at the side of the oral valve. *Oœcium* very large and prominent, covering about half of the cell, rounded above, flattened in front, and much depressed towards the very wide and shallow oral arch; surface smooth, divided into distinct areas by raised partitions. Grows in rather large tufts, which are rooted by a trunk-like mass of tubular fibres.

It is difficult, in the absence of living specimens, to form a conjecture respecting the function of the uncinate processes on each side of the cell. They are clearly not to be placed in the same category as the ordinary spines, for they exhibit a very distinctive structure, which points to some special function. Each of them is connected with a small sac-like structure, which lies close alongside the margin of the cell between the outer wall and the perigastric cavity. The front wall of the sac rises and becomes somewhat inflated towards the upper extremity, and from this portion the sharp, slightly curved spine springs, extending usually to the base of the oral valve or a little above it.

The genus *Farciminaria* is allied, through the structure of its cell, to the Membraniporidæ, from the ordinary type of which it is only distinguishable by its habit of growth and its simply chitinous zoœcium. These differences have little systematic value, and have no claim to be made the criteria of a natural division; but it may be convenient to range the forms which exhibit them as a kind of subgroup of the Membraniporidan family.

MEMBRANIPORA, De Blainville.

Membranipora perfragilis, MacGillivray (sp.).

Biflustra perfragilis, MacG. Nat. Hist. of Victoria, Decade vi. p. 27, pl. 57. fig. 1.

In his account of this species MacGillivray takes no notice of the avicularium, and I therefore supply a description and figure of it (Pl. VIII. fig. 4).

Avicularian cell very narrow, as compared with the ordinary cells, elongate, with a calcareous expansion at the bottom as in the latter; the lower third of the aperture closed in by a membranous wall, the rest occupied by a large horny operculum working on a distinct hinge, slightly hollowed at the sides and rounded above (subspatulate), the margin of the cell a good deal raised round the operculum, and somewhat expanded and bent inwards at the points where the sides of the latter are hollowed out.

The avicularium of this species is an interesting transition form, showing very clearly the morphological relation of the appendages to the normal zoœcium. It is not very freely developed in the specimens which I have examined.

I have not followed MacGillivray in referring the present species to *Biflustra*, as I am unable to find any valid distinction between that genus and *Membranipora*.

Family **Cribrilinidæ.**

Cribrilina, Gray.

Cribrilina monoceros, MacGillivray. (Pl. VIII. fig. 5.)

I have figured a very young colony of this species from Port Phillip Heads, which exhibits in its perfect simplicity a striking contrast to the adult condition. The mature cell is remarkable for the number and variety of the appendages with which it is furnished.

Family **Porinidæ.**

Porina, D'Orbigny.

Porina magnirostris, MacGillivray (sp.). (Pl. IX. fig. 6.)

Lepralia magnirostris, MacG. Proc. Royal Soc. Victoria, 1882, "Descriptions of new or little-known Polyzoa," part ii.

I cannot hesitate, looking to the many points of similarity between the two forms, to identify MacGillivray's *Lepralia magnirostris* with a *Porina* which occurs abundantly amongst Mr. Wilson's dredgings. He does not note the characteristic "special pore," but in other particulars there is complete agreement. The habit is Hemescharine, and the celliferous lamina is very stout and strong; it is twisted and sinuated and forms large chambered masses of a yellowish-brown colour. The pore is sometimes placed a good way down the cell, sometimes it is much nearer the orifice; it is raised and tubular. The whole zoarium is usually covered with an epidermal investment, which renders it difficult to make out the structure. The figure represents a young marginal cell and the avicularium of the cell below it.

Family **Cyclicoporidæ.**

Zoœcia having the front wall wholly calcified and destitute of raised margins or depressed area, with a more or less orbicular orifice.

Cyclicopora, n. gen.

Generic character.—*Zoœcia* with a perfectly simple orifice more or less orbicular. *Zoarium* (in the only known species) incrusting.

Cyclicopora prælonga, n. sp. (Pl. IX. fig. 7.)

Zoœcia (usually) of great length and of about equal width throughout, disposed in linear series; front wall depressed, almost flat, rising slightly towards the orifice, sutures little more than incised lines; surface smooth, of greyish colour, covered with punctures, which are commonly almost concealed by a shining membranous epidermis; orifice nearly circular (somewhat drawn out transversely); peristome very slightly thickened and raised, unarmed, forming a delicate rim. *Avicularia* none. *Oœcium* large, rounded, prominent, somewhat produced lengthways; surface punctured and roughened, glossy, the punctures often almost obliterated.

Zoarium of very delicate texture, forming a greyish glossy crust, on the flat surface of which the orifices show as slight elevations.

Loc. Port Phillip Heads (*J. B. Wilson*).

In this species the structure is perfectly simple; there are no appendages. The orifice is all but circular, without sinus or secondary opening. It seems entitled to stand as the type of a new group.

Family **Myriozoidæ** (part.), Smitt.

Schizoporella, Hincks.

Schizoporella subsinuata, n. sp. (Pl. VIII. fig. 1.)

Zoarium incrusting, of a dark greyish colour. *Zoœcia* ovate, quincuncial, bounded by raised lines, moderately convex, rising considerably towards the oral region (frequently a prominent nodulated boss immediately below the orifice), depressed below; surface thickly punctured and roughened by many nodules; orifice arched above, broader than high, lower margin straight, with a very minute central notch-like sinus; operculum of a dark reddish colour. *Avicularia* none. *Oœcium* large and massive, covering great part of the cell above, rounded, prominent, with the surface roughened and punctured.

The zoœcia are often invested with a thin papyraceous covering.

Loc. Port Phillip Heads (*J. B. Wilson*).

Schizoporella biturrita, n. sp. (Pl. IX. fig. 8.)

Zoœcia ovate, boundaries indistinct, very moderately convex, depressed towards the base, quincuncially arranged; surface thickly covered with rather large punctures, and with nodular risings amongst them, usually invested by a smooth and dense covering, which conceals the pores, the nodules only showing faintly through it; orifice much taller than broad, arched above, the lower margin, with the exception of a very small segment on each side, occupied by a deep bluntly-pointed sinus; peristome not elevated, unarmed; on each side of the orifice a tall, stout, tower-like process, bearing either at the back (usually) or on one side a large erect *avicularium*, extending from the base to the top of it; mandible broad and triangular below, slender and much produced above, directed upward. *Oœcium* gigantic, suborbicular, extending almost to the orifice of the cell above, the surface sloping down gradually on all sides from the elevated centre to the base (in the centre commonly a very prominent smooth umbo), thickly punctured and nodulated, the punctures generally concealed more or less by the smooth superficial investment; the two aviculiferous processes projecting one on each side in front of the ovicell.

Zoarium of a rather light yellowish-brown colour, incrusting a seaweed, and sending off free bilaminate expansions, short and broad, at intervals, which have a tendency to arrange themselves in whorls.

Loc. Port Phillip Heads (*J. B. Wilson*).

The tower-like processes constitute the striking feature of this species; they roughen the surface and give a scabrous appearance to the crust. Occasionally the avicularium is absent. The lower portion of the processes is invested by the superficial covering, which spreads over a great part of the zoarium; but it does not extend to the smooth and polished apex.

Schizoporella insignis, MacGillivray.

Schizoporella insignis, MacGillivray, Proc. Roy. Soc. Victoria, 1882.

Under this name MacGillivray has described a species which he had obtained off Port Phillip Heads, and which also occurs amongst Mr. Wilson's dredgings. It seems to me to be identical with *Schizoporella conservata*, Waters, a Tertiary fossil from South-west Victoria. I have recorded the occurrence of this form in Australia as a recent species ('Annals' for August 1882). In any case the name *insignis* could not be retained, as it had already been conferred on an African species ("Contributions" &c. 'Annals' for August 1881).

Family **Escharidæ** (part.), Smitt.

Lepralia, Johnston (part.).

Lepralia bifrons, n. sp. (Pl. VIII. fig. 3.)

Zoœcia elongate, subrectangular, quincuncially arranged, bounded by thick and conspicuous raised lines; surface flattish (sutures very shallow), punctured; orifice (primary) arched above, constricted by a prominent projection on each side, a short distance above the lower margin, which is slightly curved outwards; peristome elevated, especially at the back and sides (forming a raised rim), in front rather broad and somewhat flattened, unarmed; operculum smooth and polished, narrow (not so wide as the orifice), the space between it and the margin filled in by a horny plate, slightly hollowed out at the sides a little above the inferior margin. *Oœcium* large, suborbicular (rather broader than high), very moderately convex, punctured, a raised line round the base, within which there is a row of larger pores; peristome carried across the front of the ovicell, often rising into a projection on each side of the orifice. Immediately under the lower margin (in the oœcial cells) a large *avicularium*, broadly spatulate, short, contracted at the base, the mandibular portion much expanded and rounded anteriorly, mandible directed downwards; the space behind the mandible marked off by a very prominent denticular process on each side.

Loc. Port Phillip Heads (*J. B. Wilson*).

A curious peculiarity in this species is the want of correspondence in size between the orifice and the operculum. The latter is very narrow, and there is a space between it and the margin which is filled in by a delicate chitinous expansion. A distinct depression or furrow runs across the operculum in the line of the lateral denticles, and marks the hinge on which the movable valve works. The denticles are unusually large and prominent.

Avicularia seem to be altogether wanting on the cells which are not furnished with oœcia. On those which bear oœcia they are present and exhibit a very distinctive form and structure. They originate immediately under the lower margin of the orifice, and occupy a large portion of the area of the cell. The mandible is short and unusually broad and suborbicular in shape.

In most other cases the chamber or basal portion of the appendage is separated from the mandible by a partition, on which the latter works; but here two large denticles constitute the supports on which the valve moves, corresponding with those which occur in the orifice of the cell. The avicularium without its mandible resembles very markedly the orifice without its operculum *reversed*.

Smittia, Hincks.

Smittia reticulata, J. MacGillivray, var.
(Pl. IX. fig. 2.)

The variety of this species in which the avicularium is much elongated, with a slender mandible rounded at the extremity and placed on one side of the sinus, and often at some distance from it, instead of immediately under it, has been noticed in a previous portion of this series ('Annals' for August 1881). I now add a figure of it. Occasionally the avicularium is placed diagonally (as represented); more commonly it is straight. I am inclined to think that this form may be identical with *S. reticulata*, var. *ophidiana*, noticed by Waters in his 'Bryozoa of the Bay of Naples' (1879).

This species has a very wide range of distribution.

Smittia Landsborovii, Johnston, form *personata*.
(Pl. IX. figs. 3′, 3.)

A variety of this species occurs amongst Mr. Wilson's dredgings in which the cells bearing oœcia exhibit a curious peculiarity. The peristome (which is much raised) gives off two arms in front, which meet and unite across the orifice, leaving a circular opening below, within which the avicularium is visible. A similar variety of *Microporella ciliata* Busk has described as *Lepralia personata*, and this name may appropriately be given to corresponding varietal forms. I have already noticed an Australian variety of this species ('Annals,' August 1881), which exhibits the same structure and is also distinguished by its rich purple colour. The present variety may stand as form *personata*, and the latter as form *personata*, var. *purpurea*.

In some cases the characteristic circular avicularium is replaced by one of spatulate figure, and this occasionally assumes gigantic proportions, occupying a large portion of the front of the cell (Pl. IX. fig. 3). In British specimens a large spatulate form is commonly associated with the oœcium, placed transversely at the side of it.

In one instance a colony has occurred (amongst the dredgings from Port Phillip Heads) in which a minute spatulate avicularium takes the place universally of the usual form.

Smittia trispinosa, Johnston, vars. (Pl. IX. figs. 4, 5.)

This species, as represented in the Australian seas, is remarkable for the number and variety of its avicularian appendages. In an account of some Polyzoa from the coast of Burmah ('Annals' for May 1880) I have noticed a form under the name of var. *bimucronata*, which is distinguished by the lateral elevation of the peristome into mucronate processes, and is also furnished with a very large pointed avicularium, placed on a mound-like rising beside the orifice.

This bimucronate variety also occurs off the coasts of Victoria. Another from the same region (Pl. IX. fig. 4) is also furnished with a mounted lateral appendage, sometimes of moderate, sometimes of gigantic dimensions; but in this case the form is spatulate. Close to the orifice at the side there is also very frequently a small pointed avicularium, with the mandible slanting upwards. In addition there is on many of the cells a minute spatulate appendage unmounted on one side of the mouth.

This seems to be the variety *spathulata* of Smitt, figured in his 'Floridan Bryozoa.'

Yet another form (*munita*) occurs off Port Phillip Heads, in which, on a great proportion of the cells, there is a large rising on one side of the orifice, on which is placed an avicularium with either a broad pointed, or spatulate mandible, or one attenuated and slender towards the extremity, directed downward. A sessile, slender, subspatulate appendage is also present on many of the zoœcia. This is a very marked form.

As it occurs in the British seas *S. trispinosa* has usually two modifications of the avicularium—one with a large triangular mandible, very variously placed, the other small and oval in shape, placed laterally.

These variations are interesting morphologically, and especially so in relation to the wide geographical distribution which this species enjoys.

EXPLANATION OF THE PLATES.

Plate VIII.

Fig. 1. *Schizoporella subsinuata*, n. sp. 1 *a*. Avicularium.

Fig. 2. *Farciminaria uncinata*, n. sp. 2 *a*. Nat. size. 2 *b*. Oœcium, viewed sideways. 2 *c*. The same, front view.

Fig. 3. *Lepralia bifrons*, n. sp. 3 *a*. Zoœcium with ovicell and avicularium. 3 *b*. Orifice of cell without the operculum, showing the large lateral denticles. 3 *c*. Orifice, with the operculum *in situ*.

Fig. 4. *Membranipora perfragilis*, MacGillivray (sp.). A group of cells with the avicularium.

Fig. 5. *Cribrilina monoceros*, MacGillivray. Young cells.

Plate IX.

Fig. 1. *Menipea marginata*, n. sp. 1 *a*. Portion of the stem and branches, magnified, to show the stout habit. 1 *b*. Part of the margin of the branch, viewed in profile. 1 *c*. One of the large avicularia on the marginal row of cells. 1 *d*. The dorsal surface, showing the marginal rib and the way in which the tubular fibres originate.

Fig. 2. *Smittia reticulata*, J. MacGillivray, var. A zoœcium with the avicularium.

Fig. 3′. *Smittia Landsborovii*, Johnston, var. *personata*, n., with the normal circular avicularium showing within the opening in the peristome. 3. The same, with large spatulate avicularium replacing the usual form.

Fig. 4. *Smittia trispinosa*, Johnston, var. *spathulata*, Smitt.

Fig. 5. *Smittia trispinosa*, var. *munita*, n.

Fig. 6. *Porina magnirostris*, MacGillivray (sp.). A young marginal cell, and a mature cell (in outline) with the avicularium.

Fig. 7. *Cyclicopora prælonga*, n. gen. & sp. 7 *a*. The oœcium.

Fig. 8. *Schizoporella biturrita*, n. sp. 8 *a*. The orifice.

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Memoirs of the Geological Survey of India. Palæontologia Indica, being Figures and Descriptions of the Organic Remains procured during the progress of the Geological Survey of India. Series x. *Indian Tertiary and post-Tertiary Vertebrata.* Vol. II. Part 6. *Siwalik and Narbada Carnivora.* By R. Lydekker, B.A., F.G.S., F.Z.S., with 21 plates and 21 woodcuts. Calcutta: Geological Survey Office. London: Trübner & Co. 1884.

The Carnivora of the Siwalik and Narbada beds form a sumptuous volume of about 180 pages, illustrated with twenty-one plates and the same number of woodcuts. The memoir begins with the Mustelidæ, and gives a statement of the dental characters of the division termed Mustelinæ, comprising the weasels, glutton, badger, and their allies. The group is but poorly represented in a fossil state. In India there are species of the genus *Mellivora*, which has living representatives in India and South Africa, if, indeed, there be any valid distinction between those ratels. The *Mellivora sivalensis* was referred to *Ursitaxus* by Falconer and Cautley. It is known chiefly from cranial remains from the valley of the Ganges, and is distinct from the living species. *Mellivora punjabiensis* is a new species, founded upon a mandible; it was about the same size as the living and other fossil ratels, but had smaller premolar teeth, whereas in *M. sivalensis* the third and fourth premolars are large. Another genus, represented by a single species, is indicated by the *Mellivorodon palæindicus*. It, too, is described from mandibles. The fragments are very small, but show some interesting characters, differing from *Mellivora* in features which suggest comparison with the glutton; and it has the bluntly trenchant talon to the carnassial tooth which is characteristic of gluttons and ratels. We then pass on to the otters. The author discusses the generic dental characters of *Lutra*, and enumerates the living species of the Indian region, also the fossil species, which are mostly known from France and Italy. The Indian species are three in number—the *Lutra* *palæindica*, a new species (*Lutra bathygnathus*), and the *Lutra sivalensis*, which Falconer and Cautley referred to *Enhydriodon*, but Mr. Lydekker finds that it agrees with the existing otter in the form of the skull, although much larger. The chief distinction is in the form of the fourth premolar and the relatively greater size of the canine and outer incisor. Such variations, however, as the other species exhibit do not give any indication of their descent from other Carnivora.

The bears are a more interesting group of Carnivora, for Professor Gaudry had already indicated the transition between bears and the dogs which are met with in a fossil state. This relationship has been further elaborated by Dr. Filhol; and the author finds an almost complete transition from the true bears through *Hyænarctos*, which is essentially a bear, to *Dinocyon*, and so through *Cephalogale*, which is related to the dogs, to *Canis*. Thus the palæontologist finds it impossible to refer bears and dogs to separate families, and it is this united group which Mr. Lydekker understands by the term Ursidæ. Although the modern bears are plantigrade and pentadactylate, and the modern dogs digitigrade with only four anterior digits, some of the extinct allies of dogs were both plantigrade and pentadactylate.

Though thus united the author describes the groups separately: the Ursinæ comprise the genera *Æluropus*, *Ursus*, *Arctotherium*, *Hyænarctos*, and *Dinocyon*. The last is found in the Middle and Upper Tertiary of North America, and *Arctotherium* in the newest Tertiary of South America. The living bears are found over the greater part of the world, with the exception of Australasia and a large part of Africa. The earliest appearance of *Ursus* in Europe is in the lower part of the Upper Tertiary. In his preliminary analysis the author indicates seventeen species, while six species originally referred to *Ursus* are now grouped in other genera. The bears are divided, according to the relative width of the palatal aspect of the skull as compared with the first molar, into Macrodonts and Microdonts. Among the Siwalik bears are *Ursus Theobaldi*, which somewhat resembles the *Ursus labiatus*, but has a greater vaulting at the back part of the palate; it is regarded as the ancestor of the living species. And as the *Ursus labiatus* feeds upon insects and fruits, the author sees in the absence of hard substances in the food an explanation of the aborted molar dentition of the living Aswail, and the less developed condition of this character in its fossil ally. *Ursus namadicus* is an old species of the typical Macrodont type, which is distinguished by the size and character of the last premolar and first and second molar teeth. It most resembles the small *Ursus malayanus*, but the evidence is not sufficient to prove it to have been the parent of that type. *Hyænarctos*, originally regarded as a bear by Dr. Falconer, is represented by three fossil Indian species, besides the *H. insignis* of Montpellier and a species in the Middle Tertiary of Spain. The *H. sivalensis* is known from the cranium, mandible, and some bones of the extremities; it has been identified by Professor Flower in the Red Crag of England, though Mr. Lydekker regards the identification as doubtful. Another species is *H. punjabiensis,* and it is considered probable that the second premolar differs from the corresponding tooth of *H. sivalensis* by being inserted by two fangs, a character which differentiates it from bears and approximates it to *Cephalogale* and dogs. A third species, *H. palæindicus* has the first molar approximating to the dog-like genus *Dinocyon*; it also approximates to the true dogs in the comparative slenderness of the mandible and in the suppression of the third molar, a character which is unknown among bears. By the species *H. punjabiensis Hyænarctos* approximates towards the genus *Arctotherium*, and by the species *palæindicus* towards the genus *Dinocyon.* There is no further evidence of the descent of *Hyænarctos,* though, as the tuberculate dentition approaches most nearly to that of Bunodont Suina, it is possible that future discoveries may bridge over what is at present a considerable gap.

The Caninæ form a not less important group than the bears. The author attempts to divide the dogs into Microdonts and Macrodonts; but the differences in the proportionate width of the teeth are much less marked than among bears. Among living dogs there is a good deal of variation in the character of the premolar teeth and the number of the molars, *Otocyon* having the molars $\frac{3-4}{4}$, *Canis* m. $\frac{2}{3}$, *Cyon* m. $\frac{2}{2}$, and *Icticyon* $\frac{1-2}{2}$. So that *Icticyon* is the most specialized living dog, for with the diminished development of the molars the carnassial character increases. Among the fossil representatives is *Cynodictis* of the Quercy phosphatites, which, with some affinities to the civet tribe, has other characters linking it with the dog-like bears. *Cynodon* is a genus of the Middle Tertiary of Europe, which, in so far as it differs from *Cynodictis*, approaches *Canis,* but has a Viverrine character in the large size of the talon of the first molar of the mandible.

The modification is traced through *Amphicynodon*, in which the molars are more trenchant and compressed than in *Cynodictis*, with a stronger inner tubercle to the upper carnassial than in *Cynodon*, and other characters in the fourth premolar of the mandible indicate an approach to *Canis.* *Amphicyon* is remarkable for having a small third molar in the cranium, a character which is seen in the living *Otocyon*; but the limbs and some parts of the skull have decided resemblances to the bears. The transition is gradual from these types to *Cephalogale* and *Dinocyon.* In the former the number of cheek-teeth is the same as in *Canis,* but some characters of the premolars, like the larger inner tubercle of the fourth and the large hind talon of the first mandibular molar, indicate affinity with *Dinocyon.* In the Indian deposits the dogs comprise only two genera. *Amphicyon* is found in the middle of the Lower Tertiary of Europe; it is known from sixteen fossil species, some of which are confined to North America, but the majority are from France and Central Europe. The only fossil Indian species is *Amphicyon palæindicus.* The genus was identified by Dr. Falconer; and Mr. Lydekker distinguishes the species by the greater specialization of the first molar of the mandible. It apparently extends from the Kangra district to

Sind. The nearest European species is from Bohemia and Styria. The genus *Canis* is made to include *Vulpes*, *Lupus*, *Urocyon*, and their allies. The upper part of the Lower Tertiary of Paris has yielded a mandible, referred to *Canis*, and other remains from the phosphatites of Quercy have been referred to the same genus, though they differ from its modern representatives—indicating that typical dogs had not, at that time, appeared in Europe. Cope and Marsh have both described many canine animals from the Tertiaries of North America. Three species are found in the Siwalik rocks of India: first *Canis curvipalatus*, which is compared with the Bengal fox and the Californian *Canis littoralis*; but it tends to bridge over the gap between *Canis* and *Otocyon*, the form of the mandible especially agreeing with *Otocyon*, while resemblances are not wanting in the dentition. Another species is *Canis Cautleyi*, which is a large wolf. Mr. Lydekker compares it, as did Mr. Bose, with the living Indian wolf, *Canis pallipes*, but differences in the angular processes of the mandible and the relations of the carnassial teeth distinguish it. In some respects the Siwalik wolf is more specialized, so that the author doubts its having been the direct ancestor of the living species. A third species is indicated, and compared with the jackal, but not named.

The next family is the Viverridæ, a group which, at the present day, is related by *Genetta* to the Cats, by *Herpestes* with *Proteles* and the Hyæna, while fossil forms show it to have been connected by *Cynodictis* with the Dogs, and to exhibit a much more intimate connexion than is seen at the present day with both Cats and Hyænas. Of the genus *Viverra* the author indicates twelve species, of which four or five are recent. The genus at the present day is exclusively Asiatic, being limited to the Oriental province, with the exception of *V. civetta*, which is found in North and West Africa. The Siwalik fossil species are the *Viverra Bakeri* and a new form which the author names *V. Durandi*. The former is compared with *V. civetta* and *V. zibetha*, and is considered to have been probably the ancestor of the latter species. *Viverra Durandi* is indicated by a much larger skull, and differs from *V. zibetha* in the greater proportionate width of the frontals across the postorbital process. It is the largest known civet.

The Hyæna family comprises *Hyæna* and *Proteles*. Mr. Lydekker believes that the transition is so complete between *Hyæna* and *Hyænictis* of Gaudry, that the two genera may be united. It may, however, be convenient not to entirely efface the landmarks of evolution, of which Professor Gaudry's name is certainly one. Hyæna is an Old-World type. The living species are found in India, Persia, Asia Minor, and North and South Africa. The fossil representatives have been found in Europe, North Africa, India, and China. The described species number eleven, of which three still exist. The Indian fossil species in addition to these are *Hyæna felina*, *H. Colvini*, *H. macrostoma*, *H. sivalensis*, with indications of another. The *Hyæna felina* is most nearly allied to *H. crocuta*, but readily distinguished by the larger size of the fourth premolar of the mandible and its talons, the form of the occiput, the occasional absence of the first cranial premolar, and approximation of the second premolar to the canine. The author is disposed to believe that the *H. sinensis* of Professor Owen may be referred to this species. *Hyæna Colvini* is also known from good materials, and is characterized by having the skull and mandible more slender than in *H. felina*, by carnassial teeth of a more decided crocutine type, by the upper true molar being tricuspidate, and other characteristics of the dentition. This species makes a marked approximation to the *Hyæna crocuta*. It shows that *Crocuta* cannot conveniently be retained as a separate genus; and, as we have already noticed in other groups, the development of the carnassial teeth is attended with the diminished size of the first molar, or suppression of the first premolar of the mandible. *Hyæna macrostoma* is known from both cranium and mandible: the first molar is large, the palate long and narrow, the form of the posterior nares distinctive, the profile of the sagittal crest is more convex than in allied forms. But while the species is placed in the same genus with existing hyænas, it is regarded as forming a link between that type and the allies of the civets and dogs. From its slender and long jaws it is considered likely that in its habits it may have more resembled the wolves than the living hyænas. *Hyæna sivalensis* is not exactly the species indicated by Mr. Bose from which a good many specimens are separated. Its affinities are towards the species allied to *Hyæna striata*. It has the first molar relatively larger than in the *H. macrostoma*, the premolar shorter and wider. From the large number of species present, Mr. Lydekker is inclined to doubt whether the characters which are made use of in defining the species have really the value claimed for them. The author arranges the species according to the specialization of the teeth, *Hyæna crocuta* standing at one end of the series, with the third lobe of the fourth premolar large and the first molar small; and in the mandible the first premolar is absent, the cusp of the first molar absent, the talon small, and the second molar absent. At the other end is *Hyæna chæretis*, in which the cusp is present, and the talon large in the first molar of the mandible. The author shows, first, a gradual increase in the intervening species of the third lobe of the fourth premolar; secondly, a decrease in size of the first molar; thirdly, a disappearance of the second molar of the mandible and the first premolar; fourthly, a decrease in the talon and a decrease and eventual loss of the inner cusp of the first mandibular molar; and, fifthly, an increasing width of the premolar teeth. The carnassials also become larger as the series approaches *Hyæna crocuta*. The author draws attention to the parallelism which exists between these modifications and those seen among the dogs, cats, and, in a minor degree, among the bears.

The relationship between the lower Hyænas and *Ictitherium* is so close that the distinction between the Hyænidæ and Viverridæ seems almost to vanish, while a new genus, which is described as *Lepthyæna*, brings the Hyænidæ closer to the Cats. *Lepthyæna* was originally referred to *Ictitherium.* The hinder cheek-teeth are the same in number as in the Weasel tribe, Civets, primitive Hyænas, and Cats, but a closer resemblance is found with the Hyænas, while the fossil resembles the primitive Cats in having a talon and inner cusp to the first mandibular molar. But though it is referred to the Hyænidæ, it is not supposed to be an ancestor of *Hyæna*, but to have stronger relations with the ancestral Felidæ.

The Felidæ are defined as having the carnassials well developed, but with not more than one upper true molar or two lower true molars. In this group 13 genera are placed, and in so far as the author departs from the views of Prof. Cope he follows Prof. Mivart. No attempt is made at a linear arrangement, though the genera as arranged exhibit a progressive advance in the structure of the carnassials and a diminished number of premolars and lower molars. Three lines of development of the Felidæ are represented by the Cheetahs, true Cats, and Machærodonts. The Indian types from the Siwalik beds commence with a description of the new genus *Æluropsis*, of which only one species is known, *Æ. annectans.* The number of hinder cheek-teeth is the same as in *Lepthyæna*; the jaw is very deep, and this depth is perhaps its most distinctive character. A descending symphysial expansion of the jaw is a character common to some primitive Cats and *Machærodus.* The second genus, *Ælurogale*, is represented by a species *Æ. sivalensis*; it is distinguished from *Pseudælurus* by the vertical symphysial ridge, from *Proælurus* in wanting the inner cusp to the first mandibular molar. The species is most closely allied to the *Ælurogale intermedia*, and it is intermediate in size between the Thibetan lynx and the leopard. The third genus, *Felis*, is first known in Europe in the Middle Tertiary of Sansan, and other species occur in America in the Middle Tertiary of the Loup Fork group. *Felis cristata* is the first known of the Siwalik Cats; to this species the author refers the *Felis grandicristata* of Bose. In many respects the skull of the lion approaches nearer to the fossil, though it agrees with the tiger in the relative proportions of face and cranium, and the greater gap between the third premolar and the canine; while the skull of the jaguar in the outline of the profile most closely resembles the fossil. The specimen which was named *grandicristata* probably belonged to an old male. A second species is the *Felis brachygnathus*; the canines are too small to permit of the specimens being associated with *Felis cristata.* A third species, unnamed, is allied to the *Felis pardus*, a fourth to the *Felis lynx*, a fifth is the *Felis subhimalayana*, which was about the size of the jungle-cats of India. A sixth species is indicated, but not determined. The last genus of Cats is *Machærodus*, which commenced at the close of the Lower Tertiary and is common in the Middle Tertiary of Europe, America, and Northern India. Nine species have been described, besides several which are more or less doubtful. There are two Siwalik species, *Machærodus sivalensis* and *M. palæindicus.* The former in its cranial characters comes nearest to the American species *M. necator*; the latter also agrees with this and other American species, but in cranial characters approximates to *M.*

neogæus, a relationship which is attributed to a line of passage for American and Siwalik life through the regions to the westward of China. Several limb-bones of felines are described and figured, but it has not been found possible to refer them with certainty to species, though their general affinities are indicated. Finally *Hyænodon* is placed as the type of a family in this position. This genus with its allies was placed by Gaudry with the marsupials, by Cope in an order Creodonta, by Huxley they are placed between the Carnivora and Insectivora, and this view is provisionally adopted by the author. *Hyænodon* is otherwise only known from Europe and North America, first appearing in the Paris basin. The *Hyænodon indicus* is only known from very imperfect materials; it resembles the *H. horridus* of America in size, and makes a closer approximation to the smaller *H. Heberti* from Quercy. The part concludes with a bibliography of fossil Carnivora. There are also a preface, contents, and introductory observations, some corrections, and an index to the volume. This monograph is an exceedingly able account of the subject with which it deals, is a great contribution to the history of fossil mammals, and honourable in every way to the Indian Survey and to the author. The manner in which the recent and fossil collections in this country have been utilized in elucidating the fossils shows how great were the difficulties of working at such a distance as Calcutta upon such a subject; but there is happily little in which to differ from the author, unless it be a slight over-anxiety on his part to turn knowledge to account in extracting conclusions from materials which are not always the most satisfactory. We would suggest, too, that in the matter of geological nomenclature terms like Miocene and Pliocene, which are often indefinite, should be discarded for the local names of the deposits which are referred to. The plates show a marked improvement on those executed in India, some of them being of the highest merit. We have said nothing of the excellent arrangement of the matter, of the clear description and terse style, and full quotation of scientific materials; but these, too, merit consideration in a work which must be a standard authority in mammalian palæontology.

Report on the Zoological Collections made in the Indo-Pacific Ocean during the Voyage of H.M.S. 'Alert,' 1881–82. London: Printed by order of the Trustees [of the British Museum], 1884. 8vo, xxv & 684 pp., 54 pls.

When we know that the handsome volume before us was being prepared during the time of heavy work entailed on the Zoological Department of the British Museum by the removal of the collections from Bloomsbury to South Kensington, we are led to reflect not only on the working-capacities of that staff, but on the multifarious duties that fall on those who are entrusted with the care of our National Collections. In addition to the daily labour of receiving and incorporating the new specimens of which the Museum is only anxious to have more, of preserving those that it already has, and of improving the modes by which the more suitable are presented to the public eye, and others arranged for the better use of the student, the publication of this Report, like that of preceding papers published in this Journal and elsewhere, proves that the Admiralty and the Officers of the Navy are well aware now that collections sent to the British Museum will, with all proper despatch, be worked out, and the results added to the stock of human knowledge.

While this is, in itself, a satisfactory state of things, we think that yet another cause of congratulation is to be found in the well-advised arrangement of presenting these results in a connected form and as a complete work; we have here one of the few means by which the growing disease of specialization may be mitigated, though not, we fear, cured. The volume now under consideration is, then, first of all important from the point of view that it enables a student to gain a very close acquaintance with a large part of the marine invertebrate fauna of the Indo-Pacific Ocean as a whole; the student of the Mollusca may learn what Crustacea, Echinoderms, and Sponges live with a given set of shell-fish; and the philosophic student of the relations of different forms one with another has a rich store of facts from which he may work.

In the next place, we welcome the publication of this volume and the character of its contents, because we are fully convinced that there are great opportunities for the naval officers of such a nation as ours, if only the authorities at home will give the necessary assistance to such members of the Navy as are willing to follow in the steps of Dr. Coppinger, to whose great services as a collector Dr. Günther very properly ascribes the success of the voyage. In this connection it is well to point out that here, as in other matters of marine investigation, the American nation is far in advance of the "mother-country." In the Bulletin of the United States Fish Commission for 1883 (p. 239), Prof. Spencer F. Baird has a note on "the instruction of naval midshipmen in taxidermy, ichthyology, &c. at the United States National Museum, and on board the steamers of the U. S. Fish Commission," from which we learn that an experiment is now being made "to have as a part of the regular force of the Navy officers competent to do the scientific work for which it has generally been necessary to employ civilians, as also on any cruise to be able to utilize, to some extent at least, the opportunities of research which constantly present themselves to the inquirer."

In estimating the work done by Dr. Coppinger it is necessary to bear in mind that when the 'Alert' was in the Straits of Magellan a large collection was made; the report on this was likewise prepared by the Staff of the British Museum, and occupies the first 141 pages of the 'Proceedings of the Zoological Society' for 1881. From the Indo-Pacific, "irrespective of a number of specimens set aside as duplicates, not less than 3700, referable to 1300 species, were incorporated in the National Collection; and of these more than one third (490) were new additions, if not to science, at any rate to the Museum."

Dr. Coppinger introduces the report by a short account of the voyage, the longer account of which in his own volume is doubtless known to all our readers; he is followed by Mr. Thomas, who describes nine Melanesian skulls, and by Mr. Sharpe, who, of course, gives a careful account of the birds submitted to him. The most interesting and, from a general point of view, the most important portion of Dr. Günther's contribution is the demonstration that the view held by Sundevall, but rejected by most ichthyologists, that there is more than one species of *Amphioxus* *, is quite correct; one cannot refrain from noting the grim humour of positive science when we reflect that the battle between Semper and Häckel as to the mono- or polyphyletic origin of species was largely based on the doctrine that *Amphioxus lanceolatus* was a cosmopolitan species. Five species are recognized by Dr. Günther, one of which (*Branchiostoma bassanum*) is new.

Mr. Edgar Smith deals with 214 species of Melanesian Mollusca; it is a subject for regret that he has not drawn on his wide knowledge of this group, and given us a detailed comparative account of its distribution.

Prof. Jeffrey Bell reports on 124 Echinoderms from the Melanesian seas, and directs attention to the value of coloration in the numerous species of the genus *Ophiothrix*, to which he ascribes less importance than preceding workers; he returns to the question of the use of formulæ, which he illustrates by the Crinoidea, and he insists at some length on the doctrine that the greater part of the fauna common to different parts of the Indo-Pacific Ocean follows isothermal rather than geographical boundaries; it is clear that he has been brought to this conviction by facts and against some earlier conceptions. The Echinodermata being as a whole of wide distribution, it is very important to know that the great majority of the Crinoids are very closely limited in area; "for the elucidation of the details of this tropical fauna, we may look with almost more than confidence to the information afforded by the species of Crinoids: here, however, the cabinet naturalist can as yet only appeal to the collector."

The extent of the British-Museum collections and the great knowledge of the distribution of the higher Crustacea possessed by Mr. Miers are well shown by the report on the Crustacea which is contributed by that naturalist. The Australian student of the Crustacea must carefully study the facts here recorded, as a large number of the species here noted are not described in Mr. Haswell's recent Catalogue.

Mr. Ridley reports on the Alcyonaria and Sponges; he enters into the details of the distribution of these forms on different parts of the Australian coast, and summarizes his results in tables so arranged as to afford considerable information at a glance.

* We must ask pardon for using for this Cephalochordate the name by which it is known to all zoologists except ichthyologists.

The second part of the report deals with the collections from the Western Indian Ocean; a number of islands lying on the eastern coast of Africa, whose zoological characters were incompletely or altogether unknown, were visited by Dr. Coppinger, and "sufficient materials were accumulated to connect their natural history with that of Seychelles to the northward, and Madagascar to the southward."

Like all the recent publications of the Zoological Department, the present bears ample evidence of the editorial care of the Keeper: we have noted but two misprints, which are both easily corrected by the context; the plates are, on the whole, very satisfactory, but those of the Comatulids ought to have been more highly magnified, and some of the Crustacea would have been better if more work had been put into them by the artist.

We may be pardoned for suggesting to Mr. Miers that the correct form of the technical name of the Sessile-eyed Crustacea is Hedri- and not Edriophthalmata.

The Trustees have rendered a great service to science by undertaking the publication of this work; not only have they given an opportunity to the staff to show their powers of work, but they have, we believe, afforded to the Admiralty and to the country a conclusive proof that a large zoological collection need not go here and there to find describers, but that there is a body of men ready at hand to undertake the necessary labour. The fact that some groups are not represented seems to us to be only a proof that the staff might well be increased in numbers.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.

May 28, 1884.—Prof. T. G. Bonney, D.Sc., F.R.S., President, in the Chair.

The following communications were read:—

1. "On the Fructification of *Zeilleria* (*Sphenopteris*) *delicatula*, Sternb., sp., with remarks on *Ursatopteris* (*Sphenopteris*) *tenella*, Brongn., sp., and *Hymenophyllites* (*Sphenopteris*) *quadridactylites*, Gutb., sp." By R. Kidston, Esq., F.G.S.

In this paper the author noticed the fructification of three species of Ferns which have been described as belonging to the genus *Sphenopteris*, for two of which he proposed the establishment of new genera. *Sphenopteris delicatula*, Sternb., referred by Stur to *Calymmatotheca*, is made the type of one of these genera, *Zeilleria*, in which the involucres are borne at the extremity of the pinnule-segments, which are more or less produced to form a pedicel; in their earlier condition the involucres are globular, but when mature they split into four valves. In *Calymmatotheca* the fructification consists of a number of elongated sporangia arranged in a circle around a common point of attachment; in that genus also the fructifying portions are destitute of foliage-pinnules, while in *Zeilleria* there is little difference between the fertile and barren fronds. In the new genus *Ursatopteris*, established upon *Sphenopteris tenella*, Brongn., the barren and fructifying fronds are dissimilar, and the pinnæ of the latter bear two rows of alternate urceolate sporangia, which open at the apex by a small circular pore. Gutbier's *Sphenopteris quadridactylites* was shown to belong to the genus *Hymenophyllites*. The three species were described and their synonymy was indicated and discussed at some length.

2. "On further discoveries of Footprints of Vertebrate Animals in the Lower New Red of Penrith." By George Varty Smith, Esq., F.G.S.

Impressions of footprints were noticed by Prof. Harkness and Mr. Binney on the flaggy beds of the New Red Sandstone of Penrith, but they were of a somewhat indistinct character and compared unfavourably with those previously found at Brownrigg, in Plumpton. The author therefore gave a description of some which have been recently found in a quarry situate to the north of the Alston road, about three and a half miles east of Penrith. The rock consists of strongly false-bedded sandstone underlying the Magnesian Limestone.

Eleven footprints were found in the above quarry. Six of the impressions were discovered *in situ*; three of them (all different) were found on one stone near the top of the quarry; another was taken from a bed 7 feet below that from which the three impressions were taken, and the last two were taken from a bed one foot and a half lower. The remainder were either found by the workmen while quarrying, and set aside, or else discovered by the author and his brother on the newly quarried stones.

The surface of the two last-mentioned beds was in several places covered with footmarks, which in nearly every case took the same direction, namely from west to east.

It has been suggested, from the difference in size and depth of some of the impressions, as compared with the length of pace and form of others, that they represent the impressions of several different species, if not of different genera, of extinct Vertebrates.

The author also found in a quarry of the Penrith sandstone in Whinfell Wood, about three miles to the south-east of Penrith, a cast of some footprints less distinct than those previously found, and in an adjoining quarry a stone with several impressions of an entirely different character.

June 11, 1884.—Prof. T. G. Bonney, D.Sc., F.R.S.,
President, in the Chair.

The following communications were read:—

1. "On some Zaphrentoid Corals from British Devonian Beds." By A. Champernowne, Esq., M.A., F.G.S.

In this paper several sections of Corals from the Devonian system were described. They were referred to eight species of *Zaphrentis* (two being, perhaps, rather referable to *Amplexus*), one of *Campophyllum* (?), one of *Lophophyllum* (?), one of *Amplexus*, and one of *Cyathophyllum* (?). The *Amplexus* was identified with *A. tortuosus*, Phillips; two species of *Zaphrentis* were provisionally named *Z. calceoloides* and *Z. subgigantea* (the last being possibly a form of *Z. gigantea*, Lesueur); and for the *Cyathophyllum* the name *C. bilaterale* was suggested. For the remaining forms no specific names were proposed.

It was shown that the genus *Zaphrentis* is better represented in British Devonian beds than had hitherto been supposed. At the same time some corals exhibiting bilateral symmetry, and which the author himself had at first taken for Zaphrentidæ, belong to other families. It was shown that the corals of the family in question are distinguished by successive complete floors, well-defined septal characters, notably the discontinuity of the septa as vertical plates where arrested by the floors, the rudimentary condition of the secondary septa, the almost complete absence of vesicular endotheca, and, lastly, the septal fossula and other signs, internal and external, of bilateral or, more rarely, quadripartite symmetry.

2. "On the Internal Structure of *Micrabacia coronula*, Goldf., sp., and its Classificatory Position." By Prof. P. Martin Duncan, M.B. (Lond.), F.R.S., F.G.S.

Fungia coronula, Goldf., a characteristic newer Greensand Coral, found at Warminster and near Dunstable in England, and in the beds of Essen and Le Mans, is the type of the genus *Micrabacia* of Milne-Edwards and Haime, and the external characters have been carefully and accurately described by those authors. They placed the genus in the family of Aporose Corals called Fungidæ by Dana, and in the subfamily Funginæ, near the genus *Fungia* (as restricted by Dana).

The author finds that the internal structure of *Micrabacia coronula*, which he has examined carefully, confirms MM. Milne-Edwards and Haime's view of the classificatory relations of this species. After describing the characters of the base, costæ, septa, and synapticulæ in detail, he finds that there is no theca or true wall. He gives the following amended description of the genus *Micrabacia*. Corallum simple, lenticular, convex above, slightly hollowed out below, resting on the edge of the basal disk. Costæ delicate, simply granular, bifurcating at the calicular margin. Intercostal spaces crossed by synapticulæ, and having a regular series of openings leading upwards into the interseptal loculi. Septa continuous with the intercostal spaces, and formed by the junction of a process from the two nearest costæ, arched, denticulate, solid, unequal. Synapticulæ well developed in series, continuous or discontinuous, terminating moderately high up on the interrupted loculi, and ending as intercostal bars having canal-like spaces between them. Columella rudimentary.

The genus differs from *Fungia* in having the spaces on the intercostal grooves and the bars of the synapticulæ regular.

Some small corals lately brought from the Korean Sea have the shape, synapticulate arrangement, and bifurcating costæ of *Micrabacia*; but the corallum resembles in its bipartite unsymmetrical growth the genus *Dioseris* of the Lophoserinæ.

Micrabacia Fittoni, described by the author in 1866, from the Gault, is placed in the same genus as *M. coronula* with much doubt. The type has been mislaid, and the figures exhibit characters some of which resemble those of *M. coronula*; but in the absence of the specimen, it is not quite certain what are the structures represented.

MISCELLANEOUS.

On the Copulation of Difflugia globulosa, *Duj.* By Dr. Carl F. Jickeli.

Copulation and conjugation have been but rarely observed in the Rhizopoda, and of the few statements relating to the subject some are susceptible of a different interpretation. Especially since the well-known observation of A. Gruber * upon the process of division in *Euglypha alveolata*, many of these statements may justly be regarded with doubt. For this reason I may here describe a process of copulation in *Difflugia globulosa* which I observed at Jena in December of last year.

One morning I found in a watch-glass, in which I was breeding Infusoria and Rhizopoda, two specimens of the *Difflugia* united. The animalcules clung together by the mouth-openings. Their carapaces were entirely filled with protoplasm, and further four very long pseudopodia, unusually lively in their movements, issued from the point of union of the two individuals. The carapaces were of equal size, but one of them much more transparent than the other. When the creatures were isolated by means of a fine pipette they still remained united. About the same time in the morning of the following day, therefore four-and-twenty hours later, the two animalcules were still united, and both carapaces were quite filled with protoplasm; but the action of the pseudopodia had ceased, and at the point of union of the two mouth-apertures not the smallest plasmatic thread was to be detected. Examination at the end of another twelve hours, or thirty-six hours after the first observation, showed no alteration, but the two carapaces remained, as in the morning, fully occupied by protoplasm without the least trace of pseudopodia. Twelve hours later

* Zeitschr. f. wiss. Zool. 1881.

(*i. e.* forty-eight hours after the discovery of the state) the two carapaces were separated.

After treatment with osmium-chromium-acetic acid and staining with picrocarmine, the two carapaces were mounted in shellac. When carefully crushed only one of them appeared to be filled with protoplasm, while the other was quite empty. I was able to recognize by definite characters that the carapace previously distinguished as the lighter one was now the empty one. In the isolated plasma of the darker-coloured carapace there were two entire nuclei and one in course of breaking up. The two entire nuclei showed in a lighter-coloured basal substance a great number of small darker corpuscles, and further a distinctly double-contoured, colourless, nuclear membrane was distinguishable. Among the products of disintegration of the third nucleus a darker-coloured central body is more or less clearly distinguishable within the less coloured principal mass.

I have interpreted the process above described as a copulation, although I did not observe the union of originally separate individuals. As there can be no question of division in this case it could only be urged against my interpretation that we might here have to do with the known process of rejuvenescence, in which an animal, after forming a new shell around the gradually protruding protoplasm, finally quits the old one. I think, however, that this objection will be disposed of by the observation of the lively pseudopodial action at the commencement of the process, as also by the breaking up of one of the nuclei, and by the fact that at the end of the whole process it was not the lighter but the darker carapace that contained the protoplasmic body. All this is not in accordance with the phenomena observed in rejuvenescence. I will also not omit to mention that a great number of *Difflugiæ* of the same species which were in the same watch-glass, on careful examination showed only one or two nuclei with a single large nucleolus.

If am not mistaken, then, in interpreting the observed process as a copulation, we obtain the following facts :—

1. In the Rhizopoda, as in the Infusoria, a copulation occurs.

2. As in the Infusoria a stage of depressed vital energy occurs here during the copulation.

3. As a consequence of the process there is also a breaking-up of the cell-nucleus.—*Zoologischer Anzeiger*, no. 174, August 18, 1884, p. 449.

How Lycosa fabricates her Round Cocoon.

Dr. H. C. McCook said that while walking in the suburbs of Philadelphia lately, he found under a stone a female *Lycosa* (probably *L. riparia*, Hentz), which he placed in a jar partly filled with dry earth. For two days the spider remained on the surface of the soil, nearly inactive. The earth was then moistened, whereupon (May 2) she immediately began to dig, continuing until she had made a cavity about one inch in depth and height. The top was then carefully covered over with a tolerably closely woven sheet of white spinning-work, so that the spider was entirely shut in. This cavity was made against the glass side of the jar, and the movements of the inmate were thus exposed to view. Shortly after the cave was covered the spider was seen working upon a circular cushion of beautiful white silk, about three fourths of an inch in diameter, which was spun upwards in a nearly perpendicular position against the earthen wall of the cave. The cushion looked so much like the cocoon of the common tube-weaver, *Agelena nævia*, and the whole operations of the *Lycosa* were so like those of that species when cocooning, that the speaker was momentarily possessed with the thought that he had mistaken the creature's identity altogether, and again examined her carefully, only to be assured that she was indeed a *Lycosa*. After an absence of half an hour Dr. McCook returned to find that in the interval the spider had oviposited against the central part of the silken cushion and was then engaged in enclosing the hemispherical egg-mass with a silken envelope. The mode of spinning was as follows :—the feet clasped the circumference of the cushion, and the body of the animal was slowly revolved; the abdomen—now greatly reduced in size by the extrusion of the eggs—was lifted up, thus drawing out short loops of silk from the expanded spinnerets, which, when the abdomen was dropped again, contracted and left a flossy curl of silk at the point of attachment. The abdomen was also swayed back and forwards, the filaments from the spinnerets following the motion as the spider turned, and thus an even thickness of silk was laid upon the eggs. The same behaviour marked the spinning of the silken button or cushion, in the middle of which the eggs had been deposited.

At this stage Dr. McCook left for an evening engagement, with his ideas as to the cocooning habits of *Lycosa* very much confused indeed by an observation so opposed to the universal experience. Returning to his desk in an hour and a half he was once more assured by the sight of a round silken ball dangling from the apex of the spider's abdomen, held fast by short threads to the spinnerets. The cushion, however, had disappeared.

The mystery (as it had seemed to him) was solved: the *Lycosa*, after having placed her eggs in the centre of the silken cushion and covered them over, had gathered up the edges and so united them and rolled them as to make the normal globular cocoon of her genus, which she at once tucked under her abdomen in the usual way. This was a most interesting observation, and Dr. McCook thought had not before been made; at least *Lycosa's* manner of fabricating a cocoon had been heretofore unknown to him; and by reason of her subterranean habit the opportunity to observe it was rare. He had often wondered how the round egg-ball was put together, and the mechanical ingenuity and simplicity of the method were now apparent. The period consumed in the whole act of cocooning was less than four hours; the act of ovipositing took less than half an hour. Shortly after the egg-sac was finished the mother cut her way out of the silken cover. She had evidently thus secluded herself for the purpose of spinning her cocoon. While feeding the spider with some flies the cave was accidentally filled up, and no effort had been made to dig another, although it is the custom of this genus, in natural environment, to remain pretty closely within such a habitation while carrying the cocoon.

One month after the above date (June 4) the spider was found with the young hatched, and massed upon her body from the caput to the apex of the abdomen. The empty egg-sac still clung to the spinnerets, and the younglings were grouped over the upper part of the same. The abdomens of the little spiders were of a light yellow colour, the legs a greenish brown or slate-colour, and the whole brood were tightly compacted upon and around each other, the lower layers apparently holding on to the mother's body, and the upper upon those beneath. Twenty-four hours thereafter the cocoon-case was dropped, and the spiderlings clung to the mother alone. An examination of the cocoon showed that the young had escaped through the thin seam or joint formed by the union of the egg-cover with the circular cushion, when the latter was pulled up at the circumference into globular shape. There was no flossy wadding within, as is common with orb-weaving spiders, for example—nothing but the pinkish shells of the escaped young. On June 11 about one hundred of the spiderlings had abandoned the maternal perch, and were dispersed over the inner surface of the jar and upon a series of lines stretching from side to side. About half as many more remained upon the mother's back; but by the 13th all had dismounted. Meantime they had increased in size at least one half, apparently without food.

Dr. McCook alluded to another interesting fact in the life-history of *Lycosa*, brought to his attention by Mr. Alan Gentry. This gentleman during the winter visited a pond in the vicinity of Philadelphia (Germantown) which was frozen over. He cut a slab from the ice about eight to ten feet from the bank, and was surprised to see several spiders running about in the water. They were passing from point to point by silken lines stretched underneath the surface between certain water-plants. Several were captured, but unfortunately the specimens were not preserved. Mr. Thomas G. Gentry, who saw them, says that they were Lycosids, and from his description of the eyes he is evidently correct. It is a remarkable and novel fact to find these creatures thus living in full health and activity in mid-winter *within* the waters of a frozen pond, and so far from the bank in which the burrows of their congeners are so commonly found. It has been believed heretofore, and doubtless it is generally true, that the Lycosids winter in deep burrows in the ground, sealed up tightly to maintain a higher temperature. But the above observation opens up a new and very strange chapter in the winter behaviour of these spiders, as well as in the amphibious nature of their habits.—*Proc. Acad. Nat. Sci. Philad.*, May 13, 1884, p. 138.

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XXXVII.—Ophryocystis Bütschlii, *a Sporozoan of a new Type.* By Aimé Schneider *.

[Plate X.]

It is always an ungrateful task to publish an uncompleted work, and powerful motives are necessary to induce one to undertake it. But certain forms appear so curious, the peculiarities by which they are related to other groups sometimes render them such valuable rallying-points, and there is often so much scientific interest in knowing them even imperfectly, that to hesitate in such cases would be a mistake. It seems to me that the Sporozoan of which I am going to speak is of this number—that it is important to bring it under the notice of all the specialists whose further investigations it may guide, especially as I do not know when I shall myself have the good fortune to meet with it again. I have made of it the genus *Ophryocystis*, and I dedicate the species to Professor Bütschli, the editor of the Sporozoa in Bronn's 'Thierreich.'

It is in *Blaps* that this Sporozoan lives as a parasite.

* Translated by W. S. Dallas, F.L.S., from the 'Archives de Zoologie expérimentale et générale,' série 2, tome ii. pp. 111–126 (1884).

Being anxious, for a work on sporulation, to find cysts of very recent formation, I examined in several examples of *Blaps* the posterior extremity of the digestive tube, the rectum, when, to my great surprise, I saw in one of them, on the outer surface of this section of the intestinal canal, close to its junction with the stomach, a white, sinuous, serpentiform cord standing out strongly and with some parts much more inflated than others. Beside it there were two other similar bodies. Fig. 1 shows this appearance.

What were these productions? At the first glance it was very difficult to say; but I very soon ascertained that I had to do with Malpighian vessels adherent to the wall of the rectum, distended by peculiar contents, and of a clear white colour instead of their usual tint. I cut open these tubes, when there issued from them a quantity of little globules, which were spread over several glass slides, where some of them were observed immediately in the fresh state, only with the addition of a drop of water containing a little salt, while the others were treated with reagents.

These globules were Sporozoa, and Sporozoa such as I had never seen, although it was impossible to mistake their nature. It is, in fact, an assemblage of a number of features met with isolatedly elsewhere, but never united in a common resultant. Hence, while the general diagnosis is easy, it is in the same degree difficult to decide upon the special group to which we should refer the new form, which, as certain zoologists would say, is eminently synthetic. Is it a Gregarina? Is it a Coccidian? Is it a Myxosporidian? You may judge, for I have given what was shown by the glass slides. I have multiplied the drawings, devoting an entire plate to show all the important aspects, and endeavouring to omit none of the details that I have been able to ascertain, feeling sure that if some great genius should find this profuseness useless and impute it to poverty of imagination, specialists will thank me for my fidelity and my scruples.

All the figures have been drawn with the camera lucida and with Hartnack's immersion-lens no. 9, with the tube drawn out. At the bottom of the plate, to the left, is a scale, each great division of which represents one hundredth of a millimetre. This scale applies to all the figures except fig. 1, which is drawn under a low power.

We will commence with the examination of the objects in the fresh state.

As will be easily understood, the inflated portion of the Malpighian tubes, the seat of the parasitic production under consideration, being stopped up by these contents themselves, contains only so imperceptible a quantity of liquid, that the observation of the *Ophryocystis* in its natural medium is, or seems to me to be, impossible. This is the first difficulty of this investigation, which has many, that we cannot take the parasite under the best conditions. I therefore added a little salt water, a vehicle which I have often found to succeed with delicate parasites, but with which it would be difficult for me to say whether or not I have reason to be satisfied in the present case. Not that this salt water introduced the least apparent disturbance; such as the Protozoa were on coming into contact with it, such they remained; but it is this very persistence that troubles me, for I believe that, in its proper medium, the *Ophryocystis* displays movements, and that its form does not vary less than that of an *Amœba*, although perhaps very slowly.

If we look over all these figures (figs. 2–16), the processes, some simple, others subdivided, are those of an *Amœba*. Every one will think that it is an Amœban that I have drawn, and the mind refuses to admit the immobility of these pseudopodia. I refuse like the rest, but at the same time I cannot say that I have seen them move. This reminds us of the usual condition of the Myxosporidia; it may be said that this is the Myxosporidian phase of the *Ophryocystis*.

Like the Myxosporidia*, in fact, these bodies are *naked*, without any envelope. The true Myxosporidia also present an irregular contour bristling with processes, and, which is remarkable, these processes in them are also so inert that their nature is a subject of controversy. Lieberkühn has seen feeble amœboid movements in the species from the Pike; Gabriel, on the contrary, denies the assimilation to pseudopodia, supporting his opinion upon the fact that if the faculty of emitting processes exists (and it is clear that this cannot be contested), that of making them return into the body is wanting. Bütschli has ascertained that, under favourable circumstances, the young Myxosporidia slowly move after the fashion of an Amœba. This being the case, that naturalist is inclined to refer to the same cause all the processes with which the body of these Sporozoa is furnished; all are the result of a slow but real contractility. I think that this is also the case with the present *Ophryocystis*, and I believe that most

* See N. Lieberkühn, "Ueber die Psorospermien," Arch. f. Anat. und Physiol. 1842, p. 193; B. Gabriel, "Ueber die in der Harnblase des Hechtes sich findenden parasitischen Gebilde," Bericht d. schles. Gesellsch. 1879, pp. 26–33; O. Bütschli, "Zur Kenntniss der Fischpsorospermien," Zeitschr. f. wiss. Zool. vol. xxxv. (1880), pp. 629–651, pl. xxxi.

of these processes serve to attach it to the surface of the cells which line the interior of the Malpighian vessels.

In this naked body, with expansions which are variable in form, volume, and situation, there are, especially in large individuals, a number of refractive granules, which often extend even into the most considerable processes, and generally present a complete obstacle to the examination of the other element of the contents, the nucleus or the nuclei. In very young specimens, on the contrary, the nucleus shows itself very easily, and this is also the case in the large individuals when, as happens, the nuclei are at the base of the expansions. Before speaking at greater length of the nucleus I will remark that I have never been able to distinguish two distinct zones in the body, ectoplasm and endoplasm, as is the case in the Myxosporidia; and the expansions are so little the affair of a pure ectoplasm that, as has been ascertained, the granules often pass into their trunk. I may add further that there are *never vacuoles of any kind.*

It is especially in specimens fixed with osmic acid, stained with picrocarmine, rendered transparent with oil of cloves, and mounted in balsam, that the investigation of the nuclei gives satisfactory results. All the figures in simple outline have been drawn from such objects, and the preparations remain to guarantee the truth of the images. As may be seen by an inspection of the figures, the number of nuclei varies. It is often one, two, or three, frequently also four, five, six, or even ten. By this peculiarity, again, *Ophryocystis* resembles the Myxosporidia, although distantly; in the latter the number of nuclei is considerable, unlimited, but the size of the creature is also superior. The reader will also not fail to remember that in certain Amœbæ, such as *Amœba Blattæ**, the number of nuclei often rises to the number cited in the first case.

If in the number of nuclei the analogy is rather with the Amœbæ such as *Amœba Blattæ*, it is rather with the Myxosporidia in their structure. Each of these nuclei, in fact, is of a regularly spherical form, and contains at its centre a nucleolus, which fixes the colouring-material more energetically. In certain cases the nucleolus is double, a peculiarity which, in conjunction with the variability in the number of nuclei, would lead us to assume a division of nuclei. I have therefore endeavoured to distinguish traces of this division in my preparations, but have found none sufficiently clear to exclude the idea of an injury in preparation, of a deforma-

* O. Bütschli, "Beiträge zur Kenntniss der Flagellaten und einigen verwandten Organismen," Zeitschr. f. wiss. Zool. Bd. xxx. (1878), p. 205.

tion, and I prefer to leave the matter in abeyance. The advocates of plasmodium can bring it in here if they please and agaricize over the whole. What may also enable them to plasmodiate in this case is, that the size of all these nuclei seems to be nearly the same. This therefore is a point which will require a serious examination from all those who may hereafter meet with *Ophryocystis Bütschlii*.

I admit that in order to pass from these states to the following the transition is wanting, and this is the difficulty that hampers me. There can be no doubt that the state of cyst and that of spore are posterior to the preceding states. Cysts with their spores are shown, for example, in figures 29–35. Their form, their dimensions, and the equatorial line which they present do not allow us to mistake them. It will be admitted, then, that figures 28, 18, and 16 show the first beginnings of encystment. But when these stages are rendered transparent we never find more than two nuclei, one in each half; and when we examine forms like that shown in fig. 27, which seem destined to furnish the cysts by their conjugation with another of the same kind, we never find in them more than one nucleus. After this what becomes of the amœboid stages with multiple nuclei if they are not destined to be encysted? and how can they be reserved for encystment when out of my two slides, each containing more than 100 *Ophryocystes*, I have never seen a young cyst with more than two nuclei? It is very true that the older cysts (figs. 29 and 23) contain six nuclei; but, in the first place, it can be proved that these cysts are older, and, in the second place, these six nuclei are very inferior in size to those of the amœboid forms in question, so that, leaving out of consideration the age of the cyst, which is decisive, we cannot even derive these cysts directly from the amœboid states with multiple nuclei. The question recurs: What fate awaits these amœboid stages? This is especially a matter for investigation. The imagination which might at once derive them from a fusion of several individuals into a plasmodium, could with no more trouble destroy its work, and say that, when the period of reproduction arrives, the plasmodial mass splits up into fragments with a single nucleus; but this mode of stopping up the gaps of observation seems to me to prepare cruel deceptions for those who practise it, and the best plan is to appeal from our ignorance to future investigations.

Expressly reserving this point, then, I shall continue with the description of the states which seem to me to be directly connected with reproduction by spores.

It appears to me that the prelude to this reproduction is a real conjugation, exactly like that of the Gregarinæ and Monocystidea. This is why, if we admit the plasmodial significance of the plurinucleate amœboid stages, it would be all over with conjugation in all this history; but nothing is impossible. It may also be that the plurinucleate stages serve to multiply the parasite in place by division or gemmation, and encystment only to propagate it externally from one individual to another; and if I were compelled to choose among all the hypotheses, it is upon this last that I should rest. Then the evolutive cycle would be a cycle with alternation of generations*.

The stage shown in fig. 27 I regard as one of those which precede conjugation. The body is spherical on the whole, sometimes without, but most frequently with fine processes over the whole surface. Fig. 16, if I am not mistaken, represents the very act of conjugation, for each individual still bears a tuft of filiform expansions at one of its extremities. Its resemblance to *Zygocystis* is striking. If we imagine these processes withdrawn we shall have fig. 18. The junction is effected; the two spheres are in contact by an extended plane, which, gaining a little more in breadth, will soon transform the pair into a cylinder with convex ends (fig. 28). This cylinder secretes a wall marked with an equatorial line following the line of adhesion of the conjugated individuals, and the encystment is completed. This equatorial line of the wall is a line of weaker resistance, along which will be effected the dehiscence of the envelope of the cyst. This reminds us of the similar line in the cysts of certain Gregarinæ, among others *Trichorhynchus pulcher*†.

When we render transparent the recently formed cyst after staining the nuclei, we find two nuclei, one in each hemisphere, as I have already stated, and as is shown in fig. 25. These nuclei are of the same size as in the spherical individuals (fig.

* Since writing these lines I have met with a new *Ophryocystis* in specimens of *Akis*, some of them (*Akis algeriana*) from Oran, the others (*Akis acuminata*) from Malaga, brought back by my friend M. François from a journey in Algeria and Spain. This species is more easy to study. The drawings that I possess seem to me to establish that the plurinucleate sarcodic masses really divide to produce the specimens with a single nucleus destined to conjugate. I have seen cases in which there was a rosette of four, six, eight, &c. individuals with single nucleus, united to a centre as if by a long process, and diverging from each other by the granular mass which contains the nucleus. I recommend these *Akides* to those who wish to review and complete this investigation. I shall be obliged to such persons as do not themselves take any interest in these researches if they will be kind enough to send me a little box of those insects.

† A. Schneider, "Seconde Contribution à l'étude des Grégarines," Archives de Zool. Expér. &c. tome x. p. 423.

21) taken separately. I shall only remark that I recognize the nucleolus only with some trouble in these nuclei and in those which will now be mentioned.

What becomes of the two nuclei of the cyst? It seems to me impossible to doubt the fact of their division. Each of them divides first of all into two, as shown by figs. 22 and 26. This I say is certain so far as we can arrive at certainty in comparative investigations, for the volume of the four new nuclei is so considerably inferior to that of the two original ones that the difference immediately strikes the observer. Then two of these nuclei divide again, and we get the number six, three nuclei in each half of the cyst, in the periphery of each individual. For, it must be remarked, up to this time the conjugation, which appears complete so long as we regard only the surface, has not yet had any profound effect. It is more than probable that the two plasmatic masses have not become confounded, and it is certain that the nuclei have continued the property of their original bearers.

Arrived at this point we may stop a moment to run over our recollections. I shall soon prove that in the Gregarinæ also, and in all of them, the deeper mingling of the encysted masses is late and is preceded by a special nuclear evolution. This would be a further point of analogy with the Gregarinæ. But if we consider purely and simply the cysts with six nuclei (figs. 19 and 23), may we not fancy we are looking again at one of Bütschli's figures *? In fact, since the publication of that naturalist, we know that the Myxosporidia engender bodies with six nuclei in their plasma, each of which becomes the mother-cell of two spores. Now the origin of the six nuclei appears very clear in *Ophryocystis*. They are derived from two nuclei belonging to distinct terms, nuclei which have proliferated under the influence of a conjugation. Should not this observation lead to a fresh scrutiny of the origin of the mother-cells of the spores in the Myxosporidia?

The sequel of our investigation will show us two curious facts, establishing a profound difference from the Myxosporidia. Thus, on the one hand, all the plasma of the cyst is not employed in the formation of the reproductive element, which reminds one of the Gregarinæ; and, on the other, four nuclei out of six are abandoned, a peculiarity which appears to me to be unique, and which is one of the most characteristic features of this curious form. When I found *Ophryocystis* I thought for a moment that I had one of those pure and

* O. Bütschli, *loc. cit.* pl. xxxi. fig. 36, and 'Protozoa,' pl. xxxviii. fig. 14 *b*.

simple types that everybody precedes with a *Proto*, and I was about to make a *Protocystis*, or something of the sort,—my first *proto*. But I was obliged to abstain from inscribing that date in my life, when the expulsion of the four nuclei suggested the idea that, instead of a form which could be regarded as primitive, I had undoubtedly only a degenerate product, the result of a number of transformations which only leave to *Ophryocystis* a borrowed and deceptive simplicity. In the Myxosporidia the whole of the protoplasm and nuclei divides first of all, according to Bütschli, between the two spores.

It is under the influence of these very sage considerations that I shall commence by describing the exception, seeing that the exception may very well be only a former rule.

Exceptionally, then, there is a tendency to the formation of two spores, as is normally the case in the Myxosporidia. Figs. 39 and 40 represent this stage, which is comparatively very rare. Fig. 39, drawn from the life, is particularly instructive. The mass of the cyst remains divided into two hemispheres, and each hemisphere has formed a spore and a residual mass, which are as distinctly separated as possible from each other. The two spores and the two residual masses are placed diagonally. If we had not this residual mass we should therefore have a bisporic capsule, like those of the Myxosporidia.

When things take place as just described it is not usual for the two spores to come to perfection; nearly always one of the two thrives more than the other and alone arrives at maturity. Nevertheless there are cysts which contain both their spores, although want of space has prevented my giving a drawing of one.

Pretty often, also, it happens that one of the hemispheres alone forms its spore on its own account, the other remaining barren. Fig. 37 represents a case of this kind, and it will be seen at once that the barren hemisphere has retained its three nuclei, and that in the other a single nucleus has passed into the constitution of a small spherical spore. Five nuclei, therefore, are abandoned as residue.

But the usual case is that in which, a single spore being formed, it is the common product of the two halves of the cyst, each having a fractional participation in the formation of the reproductive element. The spore then appears in the centre of the cyst, and it acquires a volume at least double that of the dwarfish spores which we have just been considering.

Fig. 41 shows, in the fresh state, a cyst of which the spore is already individualized, although still far from its definitive size. It is spherical in this stage, placed in the plane of the equator, and fitted in between two spherical hoods, which it already lifts sufficiently to cause a tolerably wide space to exist between them in the equatorial zone. Fig. 29 shows a more advanced stage, also from the life. The spore has increased in size; it has attained its definitive dimensions; it has its double wall; the two hoods which just now existed, pushed more and more towards the poles, have become obliterated. In place of the considerable number of granules that they had in the former specimen, they have only a very small number, and appear as if exhausted. Fig. 33, however, represents them as still well marked; but when we come to fig. 34, and especially to fig. 31, we find them still more reduced, and even broken up into granules, which float disseminated in the liquid that has appeared to replace them in the interior of the cyst.

While these appearances were showing themselves externally, what has taken place within the cyst? Of this we can form an idea only by comparing preparations rendered transparent.

We have seen that six nuclei existed in the cyst. Two of these nuclei placing themselves in the equatorial plane, and, according to my interpretation, fusing together and consummating the conjugation, which up to that time remained incomplete, are going to constitute the spore. The other four, continuing in their respective hemispheres, will remain immersed in the granular hoods, the destruction of which they will share. Thus figure 15 expresses, in my opinion, the commencement of the phenomenon, and it corresponds to figure 41, which we have just been considering; while fig. 17, corresponding to fig. 29 from the life, shows the perfect completion of the sporoblast.

The sole point upon which I may be mistaken relates to the fusion of the two nuclei of the spore into a single one. This is why, strictly speaking, an error may be possible. If fig. 15, instead of presenting the ideal axis which unites its two nuclei in the plane of the preparation, showed it oriented perpendicularly, the two nuclei being projected more or less one over the other would represent a single spherical or oval body, and it would no doubt be difficult in such a medium as balsam to distinguish the superposition. Thus I cannot venture to assert that, by having foreseen them, I have avoided all causes of error. There is indeed one argument, namely the diameter of the single nucleus. But if the superposition of the two nuclei be incomplete, the diameter of their projection might correspond with that of a large single nucleus.

However this may be, if the sporoblast amalgamates its two primitive nuclei into a single nucleus, the nucleus of the spore, the latter must be regarded as soon dividing into two, then into four, and in all probability into eight, in order to furnish a fraction to each of the falciform corpuscles which the spore contains when mature. Fig. 38, for example, may be thus interpreted; the nucleus of each pole of the spore has divided and given place to two others. Their position in the figure is still such that they constitute two pairs disposed obliquely and with a certain amount of regularity. In fig. 24, corresponding to the maturity of the reproductive element, we easily count seven nuclei seen in optical section; in other preparations I have found eight. Unless therefore the nuclei of the corpuscles are sufficiently elongated for each of them to present a double optical section upon the opposite walls of the spore, there would be eight falciform corpuscles, and in the second supposition only four. Fig. 20 shows four nuclei in the spore, three of which are seen obliquely or in their whole length. This is sufficient to show that we cannot exclude the idea that in fact these nuclei might present themselves twice in the optical section of a spore. Such are the results which flow directly from the examination of transparent preparations.

But while these phenomena are taking place in the interior of the spore the cysts present externally a curious spectacle. When we cut one of the Malpighian vessels gorged with *Ophryocystis*, and all the little parasites escape into the drop of the vehicle, the field of the preparation is literally covered with little hemispherical caps packed into one another to the number of four or five, six or seven, and often more, as if they were derived from the pillage of a manufactory of caps for Psorospermiæ. These are, in fact, the caps of the cysts of *Ophryocystis*. Fig. 31 shows a cyst such as one finds by hundreds; the slight pressure of the covering-glass has sufficed to force all the outer envelopes, which are no longer of use, to separate from the last-formed wall, and the cyst appears with the cast skins of its successive moults. Nowhere else, I believe, is this peculiarity presented in such a degree. As will be seen, all the envelopes bore the same line of dehiscence in the equatorial region. In fig. 32, which is that of a much younger cyst, it would seem that there had been as yet only two walls, one already withered, the other the actual envelope.

The spores of *Ophryocystis Bütschlii* have the form of navicellæ and would pretty closely resemble those of the *Monocystis* of the earthworm if the proportion of the longitudinal to the transverse diameter were not slightly different; in the present case it is on the average as four to three, or about that. Certain spores are more dilated than others in the equatorial zone, as will be seen on comparing the spores of figs. 33, 34, and 38. In fig. 35 we see a spore rounded at one of its extremities; this is an exception.

The normal spores, at maturity, all contain a very distinct remanent nucleus placed in the centre, and falciform corpuscles marked by extremely fine lines. We can recognize without the least doubt the existence of these sporozoites; but it would be impossible to count them correctly in the intact spore. I have expelled by pressure the sporozoites from some specimens, but they are carried in all directions by the return of the water when the pressure ceases. I cannot give the exact number. I have ascertained the existence of the nucleus in those which I met with free.

I do not know whether the little dwarf spores, two of which are produced in certain cysts, are corpusculated or remain clear. They are so rare that I have been unable to elucidate this point.

To enable the reader to avoid referring so often to the scale, I will here give the most constant dimensions among those relating to the description of the *Ophryocystis*:—

	μ.
Diameter of the spherical individuals with a single nucleus, destined to conjugate (such as fig. 22)	12–14
Longer axis of a cyst	16–20
Shorter axis of a cyst	13–14
Longer axis of a normal spore	12–14
Shorter axis of the same	7– 8
Diameter of the two primitive nuclei of a cyst (such as that of fig. 26)	3
Diameter of the nuclei in a cyst with six nuclei (such as that of fig. 24)	1·5– 2

Summary.

I will rapidly recapitulate the facts ascertained and the arguments which flow from them with regard to the affinities of *Ophryocystis Bütschlii* with other Sporozoa and even with some other Protozoa:—

1. Amœbiform stage, with a profusion of processes and a

facies of the latter, nothing analogous to which is known among the Sporozoa.

2. Nuclei varying in number (from one to ten and perhaps more) in these amœbiform creatures. This is an analogy with some Amœbans, and in part, but distantly, with the Myxosporidia.

These nuclei may be regarded hypothetically as increasing in number with the age and volume of the sarcodic mass which contains them. It is extremely probable that at a certain moment the latter divides into as many bodies as it contains nuclei, these bodies remaining for a time united in rosettes by delicate filaments, which are afterwards ruptured. The individuals thus produced are the agents of reproduction by the method indicated below.

3. Reproduction by conjugation of two individuals, *always uninucleated*, and production of a cyst marked with an equatorial line of dehiscence, and gradually secreting one under the other as many as ten concentric envelopes in the course of the sporulation. Conjugation not being known in the Coccidia, it is with the most differentiated Gregarinæ that these peculiarities establish a resemblance.

4. Sporulation up to this time single, rarely leading to the formation of two spores, never utilizing in the one case as in the other more than two of the six nuclei to which the two primitive nuclei of the cyst have given origin by dividing. Formation of a residual mass, or rather of two such masses, by these six nuclei and a considerable fraction of the original granular contents. It is still impossible to appreciate at its just value the importance of these facts; in any case it is not in the direction of the Gregarinæ that they would carry *Ophryocystis*, nor in that of the Coccidia. Must we say that they ally it to the Myxosporidia?

Perhaps so, if we consider that two of the nuclei of each spore disappear in the Myxosporidia. In them, as here, there is a loss of four nuclei out of six; but their disappearance takes place later, and in the actual interior of the spores in the constitution of which they have figured for a time. One might also perhaps think of the Infusoria, but this is a much more distant and uncertain analogy.

5. Formation in the spore of falciform corpuscles or sporozoites identical with those of the Coccidia and Gregarinæ, the reverse of what takes place in the Myxosporidia.

6. If, as I think will be evident to everybody, the Ophryocystidæ cannot be regarded as Coccidia because of the conjugation and the peculiar process of sporulation, or as Gregarinæ because of the presence of processes of the body

(pseudopodia) and of the sporulation, or as Myxosporidia, considering especially the falciform corpuscles, will it not be best to make them provisionally the representatives of a separate order, under the name of Amœbosporidia?

EXPLANATION OF PLATE X.

Fig. 1. Rectum of the *Blaps* at its junction with the stomach. On the surface there are sinuous projecting cords, formed by the Malpighian canals distended by *Ophryocystis Bütschlii.*

Figs. 2 to 9 and 11. Various states, such as one observes in slightly salt water. The expansions are more or less numerous, and some specimens show their nucleus or nuclei.

Figs. 10, 12, 13, and 14. Specimens stained with picrocarmine, rendered transparent with oil of cloves, and preserved in balsam. In these we clearly distinguish the nuclei furnished with one or two nucleoli.

Fig. 15. Transparent cyst with sporoblast.

Fig. 16. Two individuals conjugating.

Fig. 17. Transparent cyst with young spore.

Fig. 18. Two conjugated individuals, but still without double-contoured walls.

Fig. 19. State of conjugation, rendered transparent, to show the six nuclei.

Fig. 20. Cyst with spore. In this we see four nuclei belonging to sporozoites.

Fig. 21. Individual with a single nucleus, transparent.

Fig. 22. State of conjugation; four nuclei.

Fig. 23. State of conjugation, with six nuclei.

Fig. 24. Cyst with formed spore. We see the optical section of seven nuclei belonging to sporozoites.

Fig. 25. State of conjugation, first phase, transparent.

Fig. 26. State of conjugation; four nuclei.

Fig. 27. Individual with a single nucleus, drawn in the fresh state.

Fig. 28. Cyst at the beginning of its formation, but with double wall. The two nuclei are seen shining through.

Fig. 29. Cyst with spore and granular hoods; fresh.

Fig. 30. Cyst organizing only a single spore; fresh.

Fig. 31. Cyst with a perfectly mature spore and with sporozoites marked by fine lines. It will be remarked that the cyst is capped by two systems of membranous hoods packed one inside the other, and here slightly raised or pushed to one side.

Fig. 32. Cyst with spore, the contents of which are not yet transformed into sporozoites.

Fig. 33. Mature spore in its cyst.

Fig. 34. Spore of a somewhat different form.

Fig. 35. Another form.

Fig. 36. A spore of normal facies, isolated.

Fig. 37. A cyst with a single black spore, rendered transparent.

Fig. 38. A cleared cyst, with a spore presenting four nuclei, oriented as if they proceeded from the division of two polar nuclei.

Fig. 39. Fresh cysts organizing two spores.

Fig. 40. Another cyst in the same case, but with one of the spores affected by arrest of development.

Fig. 41. Fresh cyst with young sporoblast in the centre.

XXXVIII.—*Descriptions of Palæozoic Corals in the Collections of the British Museum* (*Nat. Hist.*).—No. II. By Robert Etheridge, Jun., and Arthur H. Foord, F.G.S.

[Plate XI.]

Chætetes cribrosa, Eichwald, sp.
(Pl. XI. figs. 1, 1 *a*, 1 *b*.)

Laceripora cribrosa, Eichw. Lethæa Rossica, vol. i. pl. 26. fig. 17, *a*, *b*, *c*, p. 490 (1860).

Sp. char. Corallum ramose, thick, subcylindrical, about 2 centim. in diameter; length unknown, owing to the specimens being imperfect. Corallites minute, contiguous, polygonal, measuring from one half to three quarters of a millim. in their greatest diameter, generally of the latter size. Transverse sections exhibit in a very characteristic manner those incipient divisions of the cells peculiar to *Chætetes*. The tabulæ, as seen in longitudinal sections, are numerous and complete.

Obs. This species differs from *C. radians*, Fischer, in its habit of growth, larger cells, thinner walls, and more numerous tabulæ. Some explanation is necessary with regard to the alteration we have made in the generic name of Eichwald's species. Finding the name "*Laceripora*" attached to one of the specimens in the collection, and this proving upon examination to be a Favositoid coral, we determined to obtain, if possible, authentic examples of Eichwald's genus in order to ascertain its structure and affinities. With this object we wrote to Prof. F. Schmidt, of St. Petersburg, asking him if he could supply the Geological Department with some specimens of "*Laceripora*" *cribrosa*, as recognized by the Russian palæontologists. Prof. Schmidt very kindly acceded to our request by sending us two specimens of that form, accompanied by the following note addressed to one of the writers of this article:—"The specimens of *Laceripora cribrosa*, Eichw., are found in a cliff called Kattripank, near Hoheneichen, in the island of Oesel. They form long branches in a coral reef consisting principally of *Stromatopora*. All the surrounding country belongs to the uppermost division of our Silurian (Etage K of my last arrangement and G of the former, = Ludlow). The *Leperditia phaseolus* is found in the same cliff; there can be no doubt about the geological horizon. I regard the mentioned layer as covering the Eurypterus-beds of . . . The mentioned coral reef passes over in the neighbourhood (at Karral) to limestone beds containing *Chonetes striatella* and *Spirifer elevatus*."

On examining our specimens by means of microscopic sections we found that they belonged to a well-marked form of the genus *Chætetes*, as defined by Nicholson. There can be little doubt that the weathering of the surface of his specimens misled Eichwald, and we find, in fact, that some portions of the surface of our specimens exhibit the same astræiform appearance as that figured by Eichwald (pl. xxvi. fig. 17 *b*, *loc. cit.*)*. This "laceration" of the cell-apertures we have endeavoured to show in fig. 1. On cutting a section a little below the surface the true structure of the fossil is made perfectly clear.

It may be well to mention two references that have been made to "*Laceripora*" of late, the one by Dr. Nicholson, the other by Dr. Lindström. The first of these authors records it in his 'Palæozoic Tabulate Corals' (p. 180); but as he had not seen specimens he confines himself to a translation of Eichwald's description, and some observations upon the genus, in the course of which he refers it provisionally to the Favositidæ, in deference to the opinion of Dr. Lindström, who had stated that it was "nothing more than a highly perforated *Favosites*" (this Journal, ser. 4, vol. xviii. p. 12, 1876). Dr. Lindström, however, reinstates "*Laceripora*" as a valid genus in his 'Index to Genera of Palæozoic Corals' (1883).

The identification of the present species with *Chætetes* extends the range in time of that genus, the Devonian being the lowest horizon in which it was before known to occur.

Locality and Horizon. Hoheneichen, island of Oesel. Upper Silurian (Etage K of Schmidt).

Collection. British Museum (Nat. Hist.).

Favosites major, Rominger, sp.
(Pl. XI. figs. 2, 2 *a*, 2 *b*.)

Thecia major, Rom. Geol. Surv. of Michigan, Lower Peninsula, C. Rominger, 1873–76, part ii. Palæontology, Corals, pl. xxv. figs. 1, 2, p. 67.

Sp. char. Corallum forming discoidal masses with tapering margins, the base being covered with a concentrically wrinkled epitheca. The calices are polygonal, with somewhat thickened walls; they are nearly uniform in size, about $1\frac{1}{2}$ millim. in diameter, but clusters of cells smaller than the average are here and there to be met with. Numerous septal spines radiate in an upward direction from the walls of the calices; they appear to form two series, the longer of which reach nearly to the centre of the calice. It is impossible to speak

* See Plate XI. fig. 1 *c*.

with accuracy as to the number of these spines on account of their imperfect state of preservation. The tabulæ are very numerous, and often anastomose. The mural pores are large and in two alternating rows.

Obs. In his remarks upon the genus *Thecia* Dr. Nicholson has drawn attention to the great discrepancy which exists between Dr. Rominger's description of *Thecia* and the characters of the type species *T. Swinderniana.* We are prepared to add our testimony in this respect to that of Dr. Nicholson, and to go much further, and to show that two out of the three species described by Dr. Rominger * under the generic name of *Thecia* belong to the genus *Favosites*; these are *Thecia* (*Favosites*) *major* and *Thecia* (*Favosites*) *ramosa*. Upon the *specific* identity of the last-named species we are unable to offer an opinion, owing to the very unfavourable condition of the specimen. It may be observed, however, in passing that Dr. Rominger remarks † that it is sometimes difficult to distinguish specimens of this form from "similarly altered stems of *Favosites radiciformis*, with which they are found associated." The remaining species, viz. *Thecia minor*, is without doubt a *Thecia*. Its external characters, where these are well preserved, are so like those of *T. Swinderniana* (with which its author has indeed compared it), that we should hesitate to separate it from that species. Its internal structure has been much obscured by becoming beekitized.

The mingling of two distinct types (*Thecia* and *Favosites*) under one generic description accounts for the divergence between the characters of *Thecia* as elucidated in the first instance by Milne-Edwards and Jules Haime ‡, and more recently by Nicholson §, and Dr. Rominger's definition of the genus. It should be noted that Dr. Rominger institutes a comparison between his *Thecia major* and *Favosites Forbesi* (var. *discoidea*), as figured and described by Dr. Ferdinand Römer in his 'Silurian Fauna of Western Tennessee,' and further, in his description of *T. major*, remarks upon the "perfect correspondence of the structure of *Thecia* with *Favosites*" as exemplified in one of the specimens he figures ||. We can trace no specific resemblance between the present species and *Favosites Forbesi*, var. *discoidea*; but it is interesting to observe the tendency in the mind of the author of

* *Loc. cit.* p. 67.
† *Loc. cit.* p. 69.
‡ 'Comptes Rendus,' t. xxix. p. 263 (1849).
§ Pal. Tab. Corals, p. 236 (1879).
|| *Loc. cit.* pl. xxv. fig. 2.

Thecia major to refer that species to the very genus to which a more searching investigation proves it to belong.

Locality and Horizon. Louisville, Kentucky. Niagara Group (Wenlock Limestone).

Collection. British Museum (Natural History).

EXPLANATION OF PLATE XI.

Fig. 1. *Chætetes cribrosa*, Eichw., sp. Surface enlarged, to show the effects of weathering.

Fig. 1 *a.* Tangential section, enlarged about twenty-five times.

Fig. 1 *b.* Longitudinal section, similarly enlarged.

Fig. 1 *c.* Enlargement of surface, after Eichwald, tab. xxvi. fig. 17 *b.*

Fig. 1 *d.* Section cut longitudinally, *ibid.* fig. 17 *c.*

Fig. 2. *Favosites major*, Rom., sp. Tangential section, showing septal spines, enlarged about twenty-five times.

Fig. 2 *a.* Longitudinal section, similarly enlarged.

Fig. 2 *b.* Another portion of the same section as 2 *a*, showing the septal spines more distinctly.

XXXIX.—*Diagnoses of new Species of* Pleurotomidæ *in the British Museum.* By Edgar A. Smith.

The species of this family in many instances do not range themselves satisfactorily in any of the numerous genera and subgenera into which it has been subdivided. I have therefore, in publishing these descriptions, referred all, with the exception of the species of *Bela* and *Cithara*, which are fairly distinguished, to the comprehensive genus *Pleurotoma*, indicating in brackets the section of the genus to which each species appears to be most nearly related.

Several of the species here described are from the Persian Gulf and Jamaica, and these, I should add, were presented to the Museum by one of its most liberal donors of specimens, the late Robert McAndrew, Esq. Other diagnoses of species of Pleurotomidæ have already been published in these 'Annals,' *vide* vol. xix. (1872), pp. 488–501, and vol. x. (1882), pp. 206–218, 296–306.

Pleurotoma (*Drillia*) *Portia.*

Testa fusiformis, pallide roseo-rufescens, circa medium anfractuum zona lata alba ornata; anfract. 8, convexi, primi duo læves, sequentes duo granulati, cæteri costis tenuibus flexuosis 12–14 (in anfr. ultima basim versus obsoletis) instructi, liris spiralibus 5–6 (in anfr. ultimo circiter 20) cancellati; anfr. ultimus basi attenuatus, infra peripheriam zona secunda alba ornatus; apertura angusta, longitudinis totius $\frac{4}{9}$ adæquans; labrum paululum pone marginem valde incrassatum, superne distincte sinuatum, intus infra sinum dente parvo munitum; columella callo tenui superne labro juncto, induta: canalis angustus, leviter productus.

Long. 9 mill., diam. $2\frac{2}{3}$.

Hab. Persian Gulf (*Col. Pelly*).

The granulation of the third and fourth whorls is produced by the longitudinal ribs and spiral lirations being very close together, and the points of intersection being granulous. The spiral liræ on the remaining whorls are slightly acutely prominent on crossing the costæ. In two specimens a second obsolete tooth within the labrum situated a little below the other is traceable. The whitish bands are not very clearly defined, but appear to blend gradually with the ground-colour of the shell.

Pleurotoma (*Drillia?*) *amœna.*

Testa fusiformis, dilute flavescens, circa medium anfractuum albo zonata; anfract. 8, convexi, primi 2 læves, cæteri longitudinaliter costati (in anfr. ultimo costis 18 infra medium desinentibus) spiraliter lirati, liris supra costas nodulosis (in anfr. superioribus 5–6, in ultimo circiter 15, paucis ad basim enodatis); apertura longit. totius $\frac{2}{5}$ adæquans; canalis angustus, paululum elongatus.

Long. 14 mill., diam. fere 5.

Hab. New Zealand.

Two of the spiral lirations a little below the suture are finer than the others. The whorls are markedly convex and the apical ones are large.

Pleurotoma (*Drillia?*) *auriformis.*

Testa fusiformis, paululum turrita, albida vel pallide lutescens; anfractus 9, primi duo læves, convexi, sequentes 2 medio carinati, cæteri superne oblique planulati, medio leviter angulati, deinde planiusculi, costis circiter 14 parum prominentibus (in anfr. ultimo infra medium sensim evanescentibus) et liris spiralibus 6–7 (in anfr. ultimo circiter 20) quarum illæ supra angulum sitæ quam cæteræ tenuiores sunt, cancellati; apertura longit. totius $\frac{4}{9}$ adæquans; labrum paululum pone marginem incrassatum, superne sinu conspicuo, aliquanto profundo et dextrorsum producto ornatum, intus dentibus obsoletis 2–3 munitum; canalis subelongatus, angustus; columella liris transversis 3–4 haud conspicuis ornata.

Long. 9 mill., diam. 3.

Hab. —— ?

The chief characteristic in this species is the peculiar manner in which the rather large sinus is directed outwards to the right, thus giving the aperture an auriform aspect. The teeth or lirations both within the labrum and on the columella are not at all strongly developed.

Pleurotoma (*Drillia*?) *pupiformis.*

Testa oblonga, angusta, subpupiformis, leviter turrita, nitens, alba, ad apicem rufescens; anfractus 8, primi duo læves, convexiusculi, tertius medio carinatus, cæteri sutura carinata sejuncti, costis bituberculatis 10 instructi; anfr. ultimus infra tuberculorum series duas, liris spiralibus tenuibus circiter 10 cinctus; apertura minima, longitudinis totius $\frac{1}{3}$ vix æquans; labrum tenue, superne paululum infra suturam profunde incisum, prope medium macula rufescenti notatum; columella callo tenui induta, juxta suturam tuberculo valido rufescenti munita; canalis breviusculus, angustiusculus.

Long. $4\frac{1}{3}$ mill., diam. $1\frac{1}{3}$.

Hab. Persian Gulf (*Col. Pelly*).

This is a very pretty and remarkable little species. The whorls increase but slowly and the last three are nearly of the same width. They are divided at the suture by a fine keel, and a double series of largish and rather acute tubercles surround the middle.

Pleurotoma (*Crassispira*?) *hebes.*

Testa elongata, subpyramidalis, flava, zona purpureo-rufa circa suturam et altera circa anfr. ultimi medium ornata, caudaque eodem colore tincta; anfractus 6, minime convexi, costis confertis circiter 17 et liris spiralibus 4–5 (in anfr. ultimo ad 13) supra costas granosis concinne clathrati; apex obtusus; apertura perparva, longitudinis totius $\frac{2}{5}$ vix æquans; labrum extus costa ultima lata incrassatum, superne paululum infra suturam levissime sinuatum; canalis brevis, angustus.

Long. 5 mill., diam. 2.

Hab. ——?

This pretty species is well characterized by its coloration and granulous clathration. For the size of the shell the apex is remarkably large and obtuse.

Pleurotoma (*Mangilia*) *denticulata.*

Testa oblonga, angusta, lutescens, prope suturam pallide fusco tincta, circa medium anfr. ultimi lineis duabus fuscis cincta, ad caudam labrique basim fusco tincta; anfractus 9? (apice abrupto), reliqui 6 convexiusculi, costis tenuibus flexuosis 12 (in anfr. ultimo basi continuis) instructi; apertura angusta, longit. totius ad $\frac{8}{19}$ æquans; labrum incrassatum, superne leviter sinuatum, intus denticulis circiter 10 munitum; columella callo tenui lævi induta; canalis brevis.

Long. $9\frac{1}{2}$ mill., diam. $2\frac{1}{2}$.

Hab. Mauritius.

This is a narrow elongated species, agreeing somewhat in form with *P. lutescens*, Reeve. There is a faint indication of spiral striation.

Pleurotoma (*Mangilia*) *grata.*

Testa acuminato-ovata, vix turrita, flavo-cornea, inter costas prope sed infra suturam purpureo-fusco tincta, et supra costas lineis purpureo-fuscis, interstitiis interruptis (in anfr. superioribus 3–4, in ultimo 4–5) cincta; anfr. 7, primi duo læves, convexi, cæteri convexiusculi, costis flexuosis utrinque leviter attenuatis 10–11 (in anfr. ultimo basi continuis) instructi, spiraliter minutissime denseque striati; apertura parva, quam longitudinis totius $\frac{1}{2}$ paulo minor; labrum album, valde incrassatum, superne distincte sinuatum; canalis angustus, brevis.

Long. 7 mill., diam. $2\frac{1}{2}$.

Hab. ——?

The ribs in this species are prettily flexuous and slightly attenuated at each end.

Pleurotoma (*Mangilia*) *Goodingii.*

Testa acuminato-ovata, turrita, alba, supra costas paululum supra medium anfractuum et ad eorum basim punctorum ruforum serie ornata; anfractus 7, primi duo convexi, læves, cæteri leviter tabulati, fere plani, costis tenuibus, pliciformibus prominentibus 9–10 (in anfr. ultimo ad basim continuis) instructi; ubique minute denseque spiraliter striati; anfr. ultimus punctorum serie tertia versus basim ornatus; apertura angusta, longitudinis totius $\frac{1}{2}$ paulo minor; labrum incrassatum, leviter sinuatum; canalis angustus, brevis.

Long. $7\frac{1}{2}$ mill., diam. $2\frac{2}{3}$.

Hab. New Zealand.

The fine prominent plicate ribs, which in the single specimen before me are continuous up the spire, and the spiral row of reddish dots on the ribs, two on the upper whorls and three on the last, are the principal distinctive characters of this very elegant species.

Pleurotoma (*Mangilia*?) *Sinclairii.*

Testa ovata, subturrita, dilute flavida, fasciis duabus rubris ad suturas inter costas ornata; anfract. 8, convexi, superne leviter planulati, costis tenuibus 16 (in anfr. ultimo basi fere continuis), transversim subcrasse lirati, liris inæqualibus supra ac inter costas continuis; apertura parva, intus fusco fasciata, longit. totius ad $\frac{5}{11}$ æquans; labrum tenue, paululum infra suturam leviter sinuatum; cauda fusca; columella callo tenuissimo induta; canalis brevissimus, obliquus.

Long. 11 mill., diam. $4\frac{1}{2}$.

Hab. New Zealand (*Dr. Sinclair*).

The proportion of the aperture to the length of the shell appears to vary. In two of the specimens from New Zealand it occupies almost half the entire length. The reddish bands are most conspicuous on the body-whorl.

Pleurotoma (Mangilia?) albolabiata.

Testa subquadrato-ovata, turrita, pallide lutea, juxta sed infra suturam saturate fusco tincta, et circa anfr. ultimi medium zona angusta ejusdem coloris cincta; anfract. 6, primi 2 politi, læves, convexi, tertius striis longitudinalibus et spiralibus numerosis (granulis ita productis) insculptus, cæteri superne breviter declivi-terque tabulati et angulati, infra angulum plani, costis subvalidis 11 (in anfr. ultimo fere ad basim continuis) instructi, et liris spiralibus 3–4 (in anfr. ult. circiter 16) et striis minute granosis inter illas ornati; apertura angusta, longit. totius $\frac{1}{2}$ æquans; labrum album, incrassatum, superne satis sinuatum, et infra sinum intus unidentatum; canalis brevis, angustus; cauda alba.
Long. 5 mill., diam. 2.

Hab. Persian Gulf (*Col. Pelly*).

Of the spiral lirations, that which is situated on the angle of the whorls is rather stouter than the rest, and is a little noduled on crossing the ribs. The brown band on the body-whorl is more decided towards the labrum, and in some specimens it is only visible on that part of the whorl.

Pleurotoma (Mangilia?) scitula.

Testa elongata, subpyramidalis, pallide lutescens, inter costas prope suturam et versus basim anf. ultimi pallido violaceo obscure tincta; anfractus 8, primi duo læves, vitrei, tertius minute granose reticulatus, cæteri convexiusculi, costis validis 6 supra spiram continuis adque basim anfr. ultimi continuis instructi, et liris spiralibus 3–4 (in anfr. ult. circiter 13) supra costas leviter incrassatis et prominentibus ornati, et inter liras minutissime denseque spiraliter puncto-striati; apertura parva, longit. totius $\frac{1}{3}$ paulo superans; columella fuscescens, liris transversis parvis 2–3 munita; labrum extus costa ultima incrassatum, supra marginem fuscescens, intus denticulis 4–5, supremo maximo, ornatum, aliquanto infra suturam leviter sinuatum; canalis angustus, brevis.
Long. 7 mill., diam. 2.

Hab. Persian Gulf (*Col. Pelly*).

This species has a hexagonal aspect when viewed with the apex turned towards the eye, owing to the six ribs being continuous up the spire. The very beautiful spiral minutely punctate striæ are only visible by the aid of a very powerful lens, and the teeth, both on the columella and within the lips, are but faintly developed.

Pleurotoma (Clathurella) perinsignis.

Testa ovato-fusiformis, pallide lutescens, circa anfract. ultimi medium linea rufa cincta; anfractus 8, primi 3 læves, convexi, cæteri convexi, paululum supra medium angulati, costis 10–12 tenuibus instructi (in anfr. ultimo versus basim evanidis), et liris spiralibus circiter 5 (in anfr. ultimo 16–20) (suprema ad angulum quam cæteræ majori), et aliis gracillimis supra angulum sitis, cincti, ubique incrementi lineis elevatis liris transversis decussantibus ornati; apertura longitudinis totius $\frac{1}{2}$ adæquans; labrum extus costa ultima incrassatum, superne leviter sinuatum; canalis brevis, angustus.

Long. $7\frac{2}{3}$ mill., diam. 3.

Hab. Japan?

Towards the labrum the ribs gradually become more remote from each other. The raised lines of growth are conspicuous and cross the spiral lirations, which are thus made minutely subgranulous.

Pleurotoma (Clathurella) gemma.

Testa oblonga, turrita, alba, costis supra angulum alterne pallide rufis albisque ornata, et circa anfr. ultimi medium zona angusta rufa ornata; anfract. 7, primi 2 læves, convexi, cæteri superne decliviter tabulati et angulati, infra angulum plani, costis rectis circiter 14 et liris subvalidis ad 6 (in anfr. ultimo circiter 15) supra costas subnodulosis forte cancellati; et supra angulum spiraliter striati; apertura longit. totius ad $\frac{1}{2}$ æquans; labrum incrassatum, superne rotunde sinuatum; canalis brevissimus, angustus.

Long. 6 mill., diam. 2.

Hab. St. Helena, in 40 fathoms.

The great peculiarity of this species is that the upper end of each alternate rib is of a pale reddish colour. The uppermost of the spiral lirations is a little stronger than the rest, and is situated around the angle of the whorls.

Pleurotoma (Clathurella) helenensis.

Testa ovata, turrita, flavescens, anfract. 7, primi 2 læves, convexi, tertius convexus, oblique tenuiter costatus, cæteri superne decliviter tabulati et angulati, infra angulum plani, costis 13, et liris spiralibus 8–9 alterne magnis parvisque infra angulum sitis (in anfr. ultimo circiter 22, quarum 5–6 circa caudam granosæ sunt) instructi, supra angulum spiraliter exiliter striati; apertura elongata, ovata, longit. totius $\frac{1}{2}$ paulo minor; labrum incrassatum, superne infra sinum parvum unidentatum; canalis brevis, truncatus.

Long. 6 mill., diam. 2.

Hab. St. Helena.

The ribs are slightly oblique and the slope or oblique tabulation occupies about one third of the upper whorls.

Pleurotoma (*Clathurella*) *lucida*.

Testa oblonga, leviter turrita, semipellucida, nitens, pallide cornea; anfract. 7? (apice abrupto) reliqui 5 subplani, costis crassis 8 (in anfr. ultimo basi continuis) instructi, et liris spiralibus supra costas nodulosis (in anfr. penult. 4, in ultimo 10) ornati; apertura angusta, longit. totius $\frac{1}{2}$ paulo minor; labrum costa ultima valde incrassatum, paululum infra suturam parum sinuatum; canalis latiusculus, ad basim truncatus.

Long. 5 mill., diam. fere 2.

Hab. Bombay.

The space between the sixth and seventh liration on the last whorl, reckoning from the suture, is rather broader than the other interstices and produces the appearance of a distinct sulcus, similar to that obtaining in *P. cavernosa*, Reeve.

Pleurotoma (*Clathurella*) *Adamsii*.

Testa breviter fusiformis, turrita, sordide albida; anfractus 5-6, primi duo læves, convexi, sequentes duo medio leviter angulati, et tenuiter crebriter costati, cæteri medio acute angulati et carinati, costis circiter 12 (in anfr. ultimo versus basim evanidis) instructi, et liris spiralibus tribus (suprema circa angulum sita) cincti, ubique spiraliter minute granoso-striati; anfr. ultimus liris circiter 15 supra costas leviter nodulosis ornatus; apertura angusta, longitudinis totius $\frac{1}{2}$ paulo superans; labrum costa ultima incrassatum, superne leviter sinuatum; canalis paululum elongatus, angustus.

Long. $3\frac{1}{2}$ mill., diam. $1\frac{1}{2}$.

Hab. Jamaica.

This species is remarkable for its short fusiform shape, the very angular whorls, and the most beautiful dense and minute granose spiral striæ. About six of the basal lirations on the body-whorl are simple, as the ribs disappear before reaching that part of the whorl. In several respects this form agrees very well with *P. jamaicensis*, but the difference of form, the different character of the sculpture of the third whorl, and the number of lirations are sufficient distinctions to separate the two species. I impose the above name on this lovely shell as a tribute to the memory of the late learned author of the 'Contributions to Conchology,' especially of Jamaica.

Pleurotoma (*Clathurella*) *Horneana*.

Testa subovata, sordide alba; anfract. 6, primi 2 convexi, læves, cæteri planiusculi, sutura profunda obliqua sejuncti, et costis validis 8 (in anfr. ultimo modo 6, illis versus labrum distantibus, ad basim productis) instructi, et liris spiralibus tenuibus 5–6 (in anfr. ultimo circiter 12, paucis ad basim supra costas nodulosis) et inter illas striis spiralibus minutis concinne ornati; apertura longit. totius ad $\frac{1}{2}$ æquans; labrum costa ultima valde incrassatum, superne satis sinuatum; canalis brevis, truncatus.

Long. $5\frac{1}{2}$ mill., diam. 2.

Hab. Persian Gulf (*Col. Pelly*).

The short ribs are produced somewhat at their upper extremity, and when they happen to be placed so that they fall between the ribs on the whorls above, a very pretty undulating suture is thus exhibited.

Pleurotoma (*Clathurella ?*) *crebrilirata.*

Testa fusiformis, fuscescenti-alba, dimidio infero anfr. ultimi fusco; anfractus 7, supremi duo convexi, læves, cæteri superne excavati, deinde convexiusculi, costis rotundatis 10, superne in excavatione fere obsoletis (in anfr. ultimo prope medium evanidis) instructi, et liris confertis supra costas leviter incrassatis (illis in excavatione sitis quam cæteræ gracilioribus) cincti; apertura parva, longitudinis totius circiter $\frac{5}{13}$ æquans; labrum tenue, paululum pone marginem costa ultima incrassatum, superne ad suturam subprofunde incisum; canalis angustus, paululum elongatus.

Long. $6\frac{1}{2}$ millim., diam. $2\frac{1}{2}$.

Hab. Persian Gulf (*Col. Pelly*).

Of the spiral lirations (about eight in a whorl) the three or four upper ones are finer than those beneath, and between the latter sometimes very slender intermediate ones are traceable. The liræ encircling the lower half of the body-whorl are faintly granulous. The slit in the labrum is situated at the suture, as in typical *Clathurellæ*, but the apical whorls are not cancellated.

Pleurotoma (*Clathurella*) *jamaicensis.*

Testa ovato-fusiformis, turrita, sordide albida, ad suturam fusco obscure tincta; anfractus 7, supremi duo læves, vitrei, tertius convexus, granose reticulatus, cæteri superne oblique tabulati, medio acute angulati, infra angulum suturam versus contracti, costis ad 11 (in anfr. ultimo fere ad basim productis) instructi, et liris spiralibus 4, suprema ad angulum sita (in anfr. ultimo circiter 15) cincti, et supra angulum interque liras ubique tenuissime spiraliter striati; apertura angusta, longit. totius quam $\frac{1}{2}$ paulo minor; labrum margine fusco, extus incrassatum, superne leviter sed distincte sinuatum, intus læve; canalis angustatus, paululum productus, levissime recurvus.

Long. 5 mill., diam. 2.

Hab. Jamaica.

The liration which encircles the whorls at the angulation is a little stouter than the rest, and on crossing the ribs is slightly thickened. The very fine striæ are minutely granulous, but this character can be seen only by the aid of a compound microscope.

Pleurotoma (*Clathurella*) *graniclathrata.*

Testa elongato-ovata, cornea; anfractus 7? (apice fracto) reliqui 4 leviter convexi, superne juxta suturam carina parva cincti, ubique costis leviter obliquis tenuibus circiter 16 et liris spiralibus paululum tenuioribus (in anfr. penultimo 5, in ultimo ad 16) supra costis granosis, pulcherrime clathrati; apertura angusta, longit. totius ad $\frac{1}{2}$ æquans; labrum fuscescens, paululum pone marginem acutum, costa ultima quam cæteræ maxime validiori incrassatum, aliquanto infra suturam sinu subamentiformi ornatum; canalis subbrevis, angustus.

Long. 6 mill., diam. 2.

Hab. Jamaica.

The chief distinctive characteristics of this species are the fine granose reticulation and the small keel winding round the top of the whorls contiguous with the suture.

Pleurotoma (*Daphnella?*) *arcta.*

Testa anguste ovato-fusiformis, albida, interdum infra suturam rufo sparsim notata; anfract. 7–8, primi 2 læves, tertius confertim granulatus, cæteri minime convexi, costis rectis parum elevatis (in anfr. penultimo circiter 15, in ult. ad 18) instructi, et liris spiralibus inæqualibus cincti, sutura leviter marginata discreti; apertura angusta, longit. totius $\frac{1}{2}$ vix æquans; columella tortuosa; labrum incrassatum, superne modice sinuatum; canalis brevissimus, angustus.

Long. 7 mill., diam. 2.

Hab. Japan and Persian Gulf.

The great peculiarity of this species is its narrow form. The coloration appears to be variable. The ordinary colour is wholly whitish, but some specimens have a reddish dot here and there below the suture and near the middle of the body-whorl; and again another example is entirely of a pale reddish hue. The third whorl is closely longitudinally and spirally sulcated, thus giving it a granulous aspect.

Bela ampla.

Testa ovata, leviter turrita, sub epidermide lutescenti albida vel pallide lilacea; anfractus 6, convexiusculi, longitudinaliter tenuiter confertim plicati (plicis in anfr. ultimo ad medium evanidis) transversim ubique tenuiter sulcati, incrementique lineis striati;

anfr. ultimus maximus, ventricosus; apertura elongato-ovata, longitudinis totius $\frac{2}{3}$ adæquans; labrum tenue, vix sinuatum; columella callo tenuissimo induta; canalis latus, brevis, aliquanto obliquus.

Long. 17 mill., diam. $8\frac{1}{2}$.

Hab. Arctic seas.

This species is remarkable for the large size of the body-whorl in comparison with the rest of the shell. When viewed with the back towards the eye it occupies rather more than two thirds of the entire length. There is the faintest indication of an angle around the upper part of the whorls.

Bela obliquigradata.

Testa breviter ovato-fusiformis, turrita, pallide rufescens; anfractus 6, primi duo læves, convexi, cæteri superne oblique tabulati et angulati, infra angulum planiusculi, costis longitudinalibus numerosis (circiter 20) tenuibus, supra angulum arcuatis, infra eum fere rectis, et liris spiralibus contiguis sed haud maxime conspicuis præter in anfract. superioribus, instructi; anfr. ultimi costæ versus basim obsoletæ, liræque spirales tenues; apertura parva, angusta, longitudinis totius quam $\frac{1}{2}$ paulo minor; columella lævis, callo albo incrassata; labrum supra angulum levissime sinuatum; canalis brevis, angustus.

Long. 10 mill., diam. 4.

Hab. —— ?

In the third and fourth whorls the spiral lirations are about two or three in number, one encircling the angulation and the rest below it; they are rather stronger than the longitudinal ribs and give the whorls a cancellated aspect. In the last whorl these liræ are much finer, very numerous, and closely packed. The two nuclear whorls are large, smooth, and white.

Cithara vitiensis.

Testa ovato-fusiformis, sordide albida; anfract. 8, primi 2 læves, cæteri convexi, costis crassis rotundatis (in anfr. ultimo 11 basi continuis) instructi, ubique minute spiraliter striati, sutura undulata sejuncti; apertura angusta, longit. totius $\frac{10}{23}$ adæquans; columella callosa, lævis; labrum extus valde incrassatum, intus denticulis circiter 10 munitum, superne levissime sinuatum; canalis brevissimus.

Long. $11\frac{1}{2}$ mill., diam. fere 4.

Hab. Totoya, Fiji Islands.

The nearest ally to this species is *C. turricula*, Reeve, from which it is distinguished by the less deep suture, by the thicker and more rounded ribs, and shorter aperture. There is a faint indication of spiral extremely pale brown lineation.

Cithara striatella.

Testa ovato-fusiformis, subturrita, alba; anfract. 7, primi 2 convexi, læves, cæteri subangulariter perconvexi, costis 7 prominentibus sed haud crassissimis (in anfr. ultimo basim attingentibus) instructi, ubique striis confertissimis, minutis, dense insculpti; apertura anguste ovata, longit. totius fere $\frac{1}{2}$ adæquans; columella fere recta, liris paucis transversis ornata; labrum costa ultima incrassatum, superne obsolete sinuatum, intus lirato-dentatum; canalis brevissimus.

Long. 8 mill., diam. 3.

Hab. Persian Gulf (*Col. Pelly*).

The seven prominent ribs are not continuous up the spire in the three specimens before me, but appear to be disposed irregularly, sometimes being continuous for two whorls and then falling alternately.

Cithara elevata.

Testa breviter fusiformis, turrita, alba; anfract. 9, primi 2–3 læves, convexi, cæteri superne declives, deinde angulati, infra angulum planiusculi, sutura perobliqua sejuncti, costis rectis modice tenuibus 10 (in anfr. ultimo ad basim continuis) instructi, et transversim tenuiter striati; apertura subangusta, longitudinis totius ad $\frac{7}{15}$ æquans; columella rectiuscula, transversim obsolete lirata; labrum costa ultima incrassatum, superne vix sinuatum, intus liratum; canalis mediocriter angustus, brevis.

Long. 15 mill,, diam. 4.

Hab. Persian Gulf (*Col. Pelly*).

Between the ribs above the angle the whorls are faintly stained with a very pale dirty olive tint. The spire is rather elongate, occupying rather more than half the entire length of the shell.

Cithara Waterhousei.

Testa ovata, alba, aurantio-rubro zonata; anfract. 8? (apice abrupto), ultimi 4 convexiusculi, costis leviter obliquis superne prominentibus instructi (in anfr. ultimo 10, basi continuis), ubique minutissime spiraliter striati, sutura profunda discreti; apertura longit. totius $\frac{1}{2}$ paulo superans; columella paululum obliqua, transversim irregulariter lirata; labrum extus incrassatum, intus denticulatum, suturam versus sinu parvo incisum; canalis brevissimus.

Long. 9 mill., diam. $3\frac{1}{2}$.

Hab. ——?

The bands on the body-whorl are so numerous as to give the shell at a little distance the aspect of being uniformly reddish orange. The upper ends of the ribs are prominent and somewhat acuminated; they are not continuous up the spire, but are alternate. Around the cauda of the body-whorl there are a few coarsish liræ.

Cithara typica.

Testa breviter fusiformis, albida, lineis spiralibus luteis (in anfr. ultimo 5) ornata; anfr. 7, primi 3 læves, convexi, cæteri superne decliviter planulati, infra medium rotunde angulati, costis plicosis (in anfr. ultimo ad 10, basi continuis) instructi, ubique transversim spiraliter contigue lirati; apertura longit. totius $\frac{5}{11}$ adæquans; columella callo tenui labro juncto induta, liris transversis ad 10 munita; labrum extus incrassatum, intus dentatum (dente supremo maximo), superne levissime sinuatum; canalis brevissimus, rectus.

Long. $6\frac{1}{3}$ mill., diam. $2\frac{1}{2}$.

Hab. ——?

Under a compound microscope some of the very small spiral lirations are seen to be minutely granulated. The transverse banding is not very apparent.

Cithara matakuana.

Testa breviter ovato-fusiformis, alba vel dilute cæruleo-alba; anfract. 8, primi 3 læves, convexi, cæteri superne excavati, infra excavationem plani, costis superne in medio anfractuum subito truncatis instructi (in anfr. ultimo 11 fere ad basim continuis), striis tenuissimis spiralibus incrementique lineis ubique minute striati; apertura longit. totius $\frac{2}{3}$ paulo superans; columella callosa, transversim valde lirata; labrum extus valde incrassatum, intus (ad 10) valde dentatum, prope suturam leviter sinuatum; canalis brevissimus.

Long. 10 mill., diam. 4.

Hab. Mataku, Fiji Islands.

In this species the upper half of each whorl is concave, the lower flat and ribbed, the ribs not extending into the concavity; the teeth on the labrum are very large.

Cithara seychellarum.

Testa breviter fusiformis, alba, punctis fuscis inter costas supra angulum ornata; anfract. 8, superne angulati, inferne levissime convexi, costis tenuibus ad angulum acutis (in anfr. ultimo 11, basi fere continuis) instructi, ubique transversim tenuissime striati; apertura angusta, longit. totius $\frac{1}{2}$ paulo superans; columella fuscescens, recta, transversim tenue lirata; labrum costa validissima extus incrassatum, intus liratum; sinus minime conspicuus; canalis brevis.

Long. 14 mill., diam. $4\frac{1}{2}$.

Hab. Seychelles Islands (*Dr. E. Perceval Wright*).

The nearest ally of this species is *C. fusiformis*, Reeve, from which it may be distinguished by the sharper angulation of the whorls, more attenuated body-whorl, finer liration on the columella, and the slightly longer spire. The slight sinus towards the lower part of the labrum is comparatively conspicuous.

XL.—*The Auditory and Olfactory Organs of Spiders.* By FRIEDRICH DAHL*.

[Plate XII.]

LAST year I published, in the 'Zoologischer Anzeiger' (p. 267), a short communication upon some peculiarly articulated hairs in the Arachnida, which I interpreted as an organ of hearing. I have since continued my investigations upon this subject, as also upon the sense-organs of the spiders in general, and venture here to make known some further results.

In the first place I ascertained that the spiders have not only auditory but also olfactory perceptions, and after long seeking I succeeded in discovering in the maxillæ an exceedingly peculiar organ which, for reasons presently to be given, I think may be regarded as the olfactory organ.

But before proceeding to its description I would make some additions to the exposition of both the histological structure and the systematic significance of the auditory hairs, and also replace the indifferent woodcut representations with better drawings.

As I have already mentioned in the above-mentioned article, the auditory hairs occur upon the upper surface of the legs and palpi. I also indicated that with reference to these hairs our indigenous spiders may be divided into two groups. I have since examined, in connexion with this, nearly all the spiders that were at my disposal in a suitable state, and I can not only sustain the assertion then made, but can also make some further remarks upon the classification of the Spiders by the employment of this character.

The first group, which has been already separated upon other characters from the other spiders, I characterized as follows :—

* Translated by W. S. Dallas, F.L.S., from the 'Archiv für mikroskopische Anatomie,' Band xxiv. pp. 1-10.

I. Tibia with two rows of auditory hairs, metatarsus with only one hair, and *the tarsus with a cup without hairs.*

Upon this it is to be remarked that the auditory hair is wanting upon the metatarsus of the fourth pair of legs*, and that one of the rows upon the tibiæ sometimes consists of only a single hair, as, for example, upon the anterior tibiæ of *Erigone pusilla*, Wid. *The rudimentary cup upon the tarsus* seems to be most characteristic of this group, and I think that a special importance must be attached to it in a natural grouping, because, as a rudimentary organ, the cup has very probably no longer a purpose to serve in the animal, and therefore directly indicates relationship. The rudimentary cup occurs in the following families:—Epeïridæ, Uloboridæ, Theridiidæ, and Pholcidæ. Of the Uloboridæ I have unfortunately been able to examine only *Hyptiotes paradoxus*, C. K., and even of this only a rubbed specimen, so that I recognized its belonging to this group only from the small cup just before the middle of the tarsus. The position of this family among the Orbitelariæ, which had already been selected on account of the form of the net, is completely confirmed by this character. An instinct so specially developed as the weaving of the peculiar geometric web is indeed as important as an organ, it being extremely improbable that *so singular* an instinct could be developed independently in different animals.

In accordance with my division into two groups, I am led to separate the genus *Phyllœca*, established by me †, from the Agalenidæ, and to refer it to the Theridiidæ, although several other characters would seem to justify the former position.

In *Pachygnatha* and *Tetragnatha* there are auditory hairs upon the femora also, and, indeed, hitherto I have found them in this position only in those genera. They stand in two rows near the base. This fact confirms the relationship of the two genera, already deduced from other characters by Bertkau ‡. I therefore, after his example, group them together as Pachygnathidæ in the same family, and refer this to the Orbitelariæ. Thus, as in all other groups, so also among the Orbitelariæ, we should have a genus which has exchanged net-weaving for a free mode of existence. *Pachygnatha* further approaches the Epeïridæ also in the greater

* The genus *Zilla* seems to be the only exception.

† Schr. d. naturw. Ver. für Schlesw.-Holst., Bd. v. p. 61; and 'Analytische Bearbeitung der Spinnen Norddeutschlands,' Kiel (1883), p. 49.

‡ Bertkau, "Versuch einer natürlichen Anordnung der Spinnen," in Arch. für Naturg. (1878).

number of the auditory hairs upon the tibiæ. There exist four in one row, whereas usually in the Theridiidæ the number three is not exceeded. *Steatoda* indeed constitutes an exception on the one side; and on the other, among the Epeïridæ, the number is less in *Singa* and *Cercidia*.

II. *The tarsus not with a rudimentary auditory cup*, seldom quite without auditory hairs (*Dysdera*), usually, as well as the metatarsus and tibia, with a considerable number. The cups in this group are much less characteristically developed.

Territelariæ.—Unfortunately of this group I had no fresh examples at my disposal, and on the spirit-specimens of the zoological collection in Kiel, which Prof. Möbius kindly made over to me for examination, the auditory hairs were for the most part broken off. So much, however, appeared to be certain, that here a considerable number of rather irregularly placed hairs exists upon the last joints of the limbs. If this be correct, the group stands in this respect in opposition to all other spiders.

The Dysderidæ are distinguished by the small number of their auditory hairs; here there exist only one or two upon the tibiæ, upon the metatarsus one, and upon the tarsus one only in *Segestria*, while there is nothing of the kind in either *Dysdera* or *Harpactes*.

In all the other families there is a considerable number of auditory hairs upon all the three terminal joints of the limbs. But according as there are one or two rows upon the tarsus, we can again distinguish two groups here:—

1. With one row of auditory hairs upon the tarsus:—*Amaurobiidæ*, *Agalenidæ*, *Philodromidæ*, *Thomisidæ*, and *Attidæ*.

2. With two rows of auditory hairs upon the tarsus:—*Drassidæ*, *Anyphænidæ*, and *Lycosidæ*. Among the Drassidæ, however, the two rows are sometimes very close together (*e. g.* in *Prosthesima*). In *Argyroneta* also, in which the auditory hairs in general differ less from the rest, it is difficult to say whether we have before us one or two rows.

Systematically the position of the auditory hairs, especially in the first group, may be employed much more extensively for distinguishing genera and species; but upon this I cannot here go into details.

As already mentioned, the development of the cup especially differs in completeness. Besides the character given, the first group is distinguished by the very characteristic form of this cup; hence the animals of this group are specially fitted for anatomical investigation. The cup is very fine and large in *Pachygnatha*, as shown in figs. 1 and 2 *.

The hairs usually do not stand exactly in the middle of the dorsal surface, no matter whether one or two series are present, because along the middle, immediately beneath the matrix, there runs a blood-sinus (fig. 1, *bl*), in which the blood flows towards the body. This is recognized in the preparation by its finely granular nature. Beneath the blood-vessel lies the main nervous cord of the leg (*n*), which may be pretty easily detected in the dense mass of transversely-striated muscles by its long irregularly arranged nuclei. From this main cord branches are given off to the individual hairs. If we wish to obtain a distinct picture of the course of the nerves, we must not make an exactly sagittal section, but the section must form an acute angle with the sagittal plane.

The delicate nervous branches which run to the cups are generally surrounded by pigment-grains, and thus their course is rendered particularly recognizable. The pigment accumulates especially beneath the chitinous envelope, and at the spot where the nerve passes into the main nervous cord. Before this passage the nerve is surrounded by three or four lighter ovals, as is shown in the figure, and these also are bounded by pigment-grains. The cup, the side walls of which are formed by the chitinous integument, is various in form, very shallow in the Chernetidæ, for example, and in the spiders usually more or less globular. In *Pachygnatha Listeri*, Sund., it is furnished with granular longitudinal costæ. At the bottom of this cup there is a second smaller cup, which projects freely from the bottom of the large one. This is filled with a finely granular substance, upon the surface of which the hair is inserted, while the nerve enters its lower part. The auditory hairs are probably never quite simple at the apex, certainly often very shortly and indistinctly plumose, but sometimes, as in the Lycosidæ, and especially in *Segestria*, almost pectinate. When several are present a gradual increase outwards is always shown. Rarely there is a smaller and, as it were, accessory hair between those growing regularly. When such a hair is present it is always very closely approximated to the neighbouring ones. When two rows are present side by side, the shorter one usually increases more rapidly in length, so that the last hairs do not differ too much in length; and this circumstance sometimes renders it possible in doubtful cases to recognize whether we have before

* In staining my preparations I employed Grenacher's hæmatoxylin-solution, which here, as in insects, gives the best nuclear staining.

us one or two rows, as the hairs then are alternately larger and smaller.

The rudimentary cups upon the tarsus are usually of about the form shown in fig. 3. The connexion with the internal space is here completely cancelled. Sometimes also the upper surface is almost entirely closed, so that then there remains only a vesicle in the integument. Moreover, the hair on the metatarsus in many cases shows only a small amount of mobility, far inferior to that of the tibial hairs. Perhaps in time this hair also will meet with the same fate as the hair of the tarsus.

After the appearance of my communication in the 'Zoologischer Anzeiger' I was for a time in doubt whether the sound-waves were the *sole* adequate excitation for the auditory hairs. The ground of this doubt was furnished by the consideration, which was even then indicated, that the hairs are also fitted to convey the sensation of a puff of air. Thus, if one blows upon a Lycosid, for example, when it is slowly running along or resting quietly, it draws up the legs to the body. As it decidedly does this involuntarily, and there can be no question of an actual fright of the spider, I thought that we must recognize in this an instinctive protective arrangement of some kind. Perhaps the animal would instinctively hold fast, and at the same time present to the wind as small a surface as possible. But if I only blew as strongly as would occur at the utmost in the wind, I observed scarcely any shrinking. The strong and sudden shock of the wind would therefore have to be a painful over-excitation of the organ, and the shrinking a sign of pain. But if the hairs really serve for the perception of a breath of air, we must at the same time ascribe to them the other function of sound-perception, as we are compelled to assume that every movement which is directly conveyed to the termination of a nerve is felt; and that the sound-waves set the hairs in motion may be directly observed, as has been previously stated.

The organ which I characterize as the *olfactory organ* is represented in figs. 4–6. Fig. 4 shows a section through the maxilla in the direction of the length of the body. In this *md* indicates the section of the maxillary gland * and *m* a muscle in section, both enclosed in connective tissue; *go* is the smooth anterior surface in front of which the mandibles move to and fro. This smooth hairless area on the anterior

* 'Analytische Bearbeitung,' &c. p. 18, resp. 6.

surface of the maxillæ is found, when seen under a high power from the surface, to be closely set with fine orifices. In perpendicular section (fig. 4, *go*) we see beneath the sieve-like integument a layer of closely approximated long cones, shown, more highly magnified, in fig. 5. Where the chitinous envelope has been slightly lifted in sectioning (as in fig. 5) these cones contract a little at the end, and in consequence they separate from each other, and thus at once show that they do not form a coherent mass.

In transverse section they exhibit a nearly regular polygonal form. Fig. 6 shows (at *a*) such a transverse section of the cones with the overlying integument. Here we see at once that each three or four orifices correspond to a cone. The cones consist of a finely granular mass (which reminds one of the so-called olfactory cones of the Copepoda &c.). At the bottom each of them contains a sharply defined nucleus, beneath which the cone is constricted, and seems to pass into a fine thread (fig. 5, *n*), which unites it to a membranous plate (*pl*). The cones are enclosed by an extremely delicate membrane, which emits small points into the pores of the integument. The membranous plate (*pl*) stretches over the whole extent of the perforated plate, and is also continued beneath the surrounding parts, where it bounds the matrix from within. A tolerably strong nerve runs to this plate; it branches off from the palpal nerve. The fine threads which run to the individual cones are therefore probably to be regarded as the final ramifications of that nerve.

If we now inquire into the origin of the organ, there can scarcely be any doubt that the olfactory cones have originated from cells of the matrix. For on the one hand there is no other trace of any matrix under this part of the integument; secondly, the olfactory cells and the cells of the neighbouring matrix are in immediate contact; and, thirdly, the membranous plate, as already mentioned, is continued beneath the matrix as an inner cellular membrane.

The organ is universally distributed within the series of the Araneæ. Nevertheless it is by no means equally perfectly developed throughout. It has its finest development perhaps in *Pachygnatha*, and for this reason I have drawn my figures from preparations of this spider.

In conclusion, we have before us the question as to what function this peculiar organ may have. We might, perhaps, in the first place, think of gland-cells, and, because it is in the neighbourhood of the mouth, suppose it to be a salivary gland, although even the general form does not seem to be very much in favour of this view. But in fresh animals I found the plate always dry. I have even captured some when engaged in sucking a fly, and on examining them could not observe any trace of a fluid upon the plate.

We are therefore driven to the conclusion that it is a sense-organ, and in this conclusion we are strengthened by the presence of a strong nerve. Let us then run over the series of our senses and inquire for what sense the organ seems to be best adapted.

The sense of touch is at once excluded, because there are no projecting parts, and, moreover, the extremity of the maxillæ is abundantly furnished with tactile hairs (fig. 4, *t*). The position alone seems to be little in favour of its being an auditory organ, as the surface is completely concealed by the mandibles, whilst an auditory organ is usually placed as openly as possible upon the surface. Further, we have already seen reason to regard the hairs above described as organs of hearing.

The notion of an organ of taste seems to be favoured by the position on parts of the mouth. Nevertheless, as already mentioned, the porous surface remains perfectly dry during the sucking of an insect. We should therefore rather regard as taste-cells a group of cells situated on the anterior surface of the suctorial groove (which can be closed as a tube), and therefore in the labrum. These cells also receive a nerve which springs from the supra-œsophageal ganglion and runs above the œsophagus.

Thus for our organ there remains only the interpretation as an olfactory organ, unless we are inclined, without any foundation, to assume the existence of a sense that is deficient in ourselves. The position would certainly be very suitable for an organ of smell; for as the plate is covered by the mandibles, it is protected from complete desiccation. The condition that the membrane of the olfactory cells, with which the particles come into contact, must be moist, could therefore here be fulfilled.

That the sense of smell is of importance to spiders, as to all air-breathing animals, needs no proof; it is, indeed, the principal purpose of this sense to test the air that is breathed. This principal function furnishes us with a ready means of convincing ourselves of the existence of a sense of smell. The animal will instinctively avoid all strong odours. I have experimented with various species and everywhere ascertained the perception of odours. I would recommend for such experiments a species of *Erigone* (*E. rufipes*, Linn.), which, in this country even in winter, may be everywhere shaken out of firs and those shrubs which retain their dried leaves. This animal not only reacts very easily, but it is also particularly well adapted for the experiments on account of its behaviour. If it be placed in a covered vessel it will soon sit quietly on the wall with its legs drawn up to its body. In this position it is not easily disturbed. But if a brush dipped in oil of turpentine or oil of cloves be brought within half a centimetre ($\frac{1}{5}$ inch) of it, it regularly runs away in a few seconds. I have not been able to observe any difference of behaviour towards different odours, nor could I succeed from its actions in drawing any conclusion as to the position of the olfactory organ, the animal being too small to allow experiments to be made with this object. This, however, is certain, that spiders perceive odours; and as we find no corresponding organ in the neighbourhood of the organs of respiration, the conclusion that the organ described is actually an organ of smell may appear not inadmissible.

A priori it would seem useless to seek for histological analogies, seeing that in other Arthropods we have no more certain knowledge as to the olfactory organ; and a comparison with the corresponding organ in Vertebrata, which are constructed upon quite a different type, does not seem to be permissible. Hence we are only the more surprised that an analogy with the structure of those animals, as it were, forces itself upon us. The olfactory cells, in fact, very vividly remind us of the so-called epithelial cells in the olfactory mucous membrane of the Vertebrata. It is true that here precisely *that* is wanting which we there interpret as olfactory cells. This interpretation, however, is still scarcely to be regarded as demonstrated, especially as the so-called olfactory cells sometimes bear vibratile cilia, and therefore at the same time must serve another purpose. The subepithelial layer would represent the membranous plate, which here certainly does not appear to consist of cells.

In this place I may perhaps call attention to another peculiar organ of the Spiders. I call it an organ on account of its peculiar structure and its general diffusion, although I can say nothing as to its function. It occurs upon the upper surface of the metatarsus of all the legs towards the extremity, and consists, as shown in fig. 7, of a few transverse folds, some of which show dot-like enlargements. In some Theraphosidæ the outermost fold is even closely and uniformly toothed on the margins. In longitudinal sections there appears under these folds (fig. 8) an oval, clearer mass of the matrix, which is surrounded by pigment-grains and might remind one of a nerve-termination. Hitherto, however, I have not seen any nerve-fibre running to it. Does this organ perhaps assist in any way in making the web? I have certainly never seen it employed in that operation.

EXPLANATION OF PLATE XII.

Fig. 1. Articulation of an auditory hair in *Pachygnatha Listeri*, Sund. *h*, auditory hair (broken short); *b*, cup; *ch*, chitinous envelope; *m*, matrix; *bl*, blood-sinus; *n*, main nervous cord of the leg; *m′*, a muscular fibre.

Fig. 2. An auditory hair with its cup, from the same animal, seen from above.

Fig. 3 *a*. A rudimentary cup of the tarsus of the same.

Fig. 3 *b*. The same seen from above.

Fig. 4. A longitudinal section through a maxilla of the same. *m*, muscle, cut through; *md*, maxillary gland, cut through; *t*, a tactile bristle; *go*, the olfactory organ.

Fig. 5. A part of the olfactory organ, more highly magnified. *ch*, perforated chitinous envelope; *z*, olfactory cones; *n*, nerve-fibres; *pl*, membranous plate passing under the olfactory cells.

Fig. 6. A part of the olfactory organ from above, more highly magnified. *a* shows the pores of the chitinous envelope, and at the same time the transverse section of the subjacent olfactory cells.

Fig. 7. Organ at the end of the metatarsus, seen from the surface.

Fig. 8. The same, in longitudinal section. *m*, matrix; *bl*, blood-vessel.

XLI.—*Description of a new Species of* Microgale.

By OLDFIELD THOMAS, F.Z.S., Natural History Museum.

IN 1882 * I had the pleasure of describing two small shrew-like Insectivores collected in Eastern Betsileo by the Rev. W. Deans Cowan, and founding for them the genus *Microgale* in the family Centetidæ; and I now have to add to them a third species much larger than either, and differing in several more or less important details. I propose to associate with it the name of Dr. G. E. Dobson, the author of the 'Monograph of the Insectivora,' in which work an account of the anatomy of the two original species has already appeared †.

Microgale Dobsoni, sp. n.

Colour and general appearance very much that of a large shrew. Head long and narrow, the nose produced into a long slender snout. Ears large and thin—laid forward they just cover the eye; their structure as in *M. longicaudata*, but their outer edge less concave. Fore feet with five well-developed toes and small equal-sized claws; fifth toes reaching to the proximal end of the terminal phalanx of the fourth. Hind

* Journ. Linn. Soc., Zool. xvi. p. 319.

† Pt. 2, pp. 86 *a* to *e* (1883).

feet far larger and heavier than in the other species, their soles covered with fine bristles; proportions of toes and claws as in the fore feet. Foot-pads six in number both before and behind. Tail about as long as the head and body, uniform blackish, very thinly haired. Body-colour throughout a dull slaty grey, the tips of the hairs lighter; lips and chin yellowish, toes nearly white.

Teeth with the essential characters of those of the other species, but the incisors and canines both above and below are simpler in structure and differently proportioned. The upper incisors are unicuspid instead of bi- or tricuspid, and the first one is more than twice as long as either the second or third. Canine long, but still slightly shorter than the first incisor, and single-rooted. Both first and second premolars small and simple. Lower jaw with the first incisor small and bicuspid, second long and unicuspid, third small and simple. Canine with a well-marked posterior basal cusp.

A second upper milk-incisor, still remaining on one side in the type specimen, is tricuspid, and very similar in shape both to the milk and permanent second incisors of the other species, a fact which seems to show that the long unicuspid permanent second incisor of *M. Dobsoni* is a later development of the tricuspid tooth present in *M. longicaudata* and *Cowani*.

The skull is in its general shape quite similar to that of *M. longicaudata*, but the lower jaw is very much heavier and stouter in proportion; its height below the second premolar being no less than 2·8 mm., while in that species it is only about 1·5 mm.

Dimensions of the type (in alcohol) —Head 37 mm.; head and body 92; tail 102; hind foot (without claws) 22; fore arm and hand 29; ear, from base of outer edge 17, above skull 11; nose to eye 20; nose to ear 30.

Skull—length 30; breadth across maxillary zygomatic processes 10·6; interorbital breadth 6·8; upper dental series 15·4.

A single nearly adult male specimen of this species was obtained by the well-known Madagascar collector, Mr. W. Waters, in the Nandésen Forest, Central Betsileo, either in February or March of the present year.

In the strictly non-fossorial character of its claws, and the complete development of its pollex, *M. Dobsoni* is a true *Microgale*, and shows no tendency whatever towards the burrowing, four-toed *Oryzorictis*, a genus with which Dr. Dobson (*l. c.*) has suggested that future discoveries might tend to unite the present one, an opinion in which, however, I am quite unable to agree.

XLII.—*Notes on the Palæozoic Bivalved Entomostraca.*—No. XVII. *Some North-American* Leperditiæ *and allied Forms**. By Prof. T. Rupert Jones, F.R.S., F.G.S.

Having lately had an opportunity of examining the Silurian *Leperditiæ* in the Museum of the McGill University (the Peter-Redpath Museum), Montreal, and the American Museum of Natural History at New York, I was enabled to make some notes and sketches, and to secure some specimens from typical localities, through the kindness of Sir William Dawson and Prof. R. P. Whitfield, respectively. In my endeavour to determine the species which I then saw I have been led to review nearly all that has been done in the elucidation of these Silurian Bivalved Entomostraca, namely, the *Leperditiæ*, *Isochilinæ*, and *Primitiæ*; and, although I do not presume that the work is as yet nearly accomplished, I venture to offer some of the results of the examination, as they may be of use to other workers among the same and similar fossils.

It seems to me that the simplest plan will be to take note of the genera and species as they occurred to me in the Museum of the McGill University, especially as thereby many of our Canadian friends will the more readily be able to refer to several of the typical forms without trouble.

Genus Leperditia†, Rouault.

Leperditia, Rouault, 1851, Bullet. Soc. Géol. France, sér. 2, vol. viii. p. 377; Jones, 1856, Ann. & Mag. Nat. Hist. ser. 2, vol. xvii. p. 84; 1870, Monthly Microsc. Journ. vol. iv. pp. 188–190; Ann. & Mag.

* For No. XIV. see Ann. & Mag. Nat. Hist. ser. 5, 1881, vol. viii. p. 332; and Supplemental Letter, *ibid.* vol. ix. p. 168; No. XV. *ibid.* 1882, vol. x. p. 358; No. XVI. *ibid.* 1883, xii. p. 243. No. XIII. treated of the Devonian *Entomides,* in September 1879, and No. XII. of the Carboniferous *Carboniæ,* in July 1879. Some confusion in the numbers inadvertently occurred at pp. 332 and 168.

† This word has been a puzzle to the author of 'The American Palæozoic Fossils: a Catalogue of the Genera and Species,' &c., 8vo, Cincinnati, 1877; for at p. 219 it is given as having been derived from "*lepis,* a scale; *dittos,* double"!! M. Rouault definitely states that it was named after a distinguished fellow-countryman, Dean of the Guild of Tailors at Rennes, and chief magistrate there, in the troublous times of 1794–5, and noted for his high character, his ability, and uprightness.

Mons. P. Lebesconte, of Rennes, favours me with the following note:—"Jean Leperdit, né à Kergrisel près Pontivy le 5 mai, 1752, est mort à Rennes en août 1823. Il exerçait à Rennes la profession de tailleur lors qu'éclata la révolution. Il fut nommé maire de Rennes pendant la Terreur; grâce à sa courageuse énergie, il sut tenir tête au farouche et sanguinaire proconsul Carrier, et sauva de l'échafaud un grand nombre de ses concitoyens. Il mourut pauvre comme il avait vécu."

Nat. Hist. 1881, ser. 5, vol. viii. p. 334; Fr. Schmidt, Mém. Acad. Impér. Sci. St.-Pétersb. 1873, ser. 7, vol. xxi. no. 2, and 1883, vol. xxxi. no. 5. Also other authors.

1. *Leperditia canadensis*, Jones.

Leperditia canadensis, Jones, Ann. & Mag. Nat. Hist. 1858, ser. 3, vol. i. p. 244, pl. ix. figs. 11–15 (including var. *nana* and var. *labrosa*); Geol. Surv. Canada, dec. iii. 1858, pl. xi. figs. 6–10; Ann. & Mag. Nat. Hist. 1881, ser. 5, vol. viii. p. 343, and p. 345, pl. xx. fig. 5.

Specimen in the McGill University Museum. Labelled "Lake Matapedia." Grey, crystalline, encrinital limestone. Two individuals, one of them good; $\frac{1}{6}$ inch long, $\frac{1}{8}$ high.

Leperditia canadensis, Jones, as restricted in the Ann. & Mag. Nat. Hist. November 1883, p. 343.

L. canadensis was originally found in the "Calciferous Sandrock" of Grenville*.

2. *Leperditia louckiana*, Jones.

Leperditia canadensis ?, Jones, Ann. & Mag. Nat. Hist. 1858, ser. 3, vol. i. p. 245, pl. ix. figs. 16, 17 [afterwards var. *louckiana* and var. *pauquettiana*].

Leperditia canadensis, var. *louckiana*, Jones, Geol. Surv. Canada, 1858, dec. iii. pl. xi. fig. 11.

Leperditia fabulites (Conrad), var. *louckiana*, Jones, Ann. & Mag. Nat. Hist. 1881, ser. 5, vol. viii. p. 343.

Specimens in the McGill University Museum. Labelled "639." "*Leperditia canadensis*, Trenton (?), Murray Bay." A block of black limestone, with valves and carapaces on a bed-plane. The *Leperditia* is not the *L. canadensis* as *restricted* in the Ann. & Mag. Nat. Hist. November 1880, p. 343, but *L. fabulites* (Conrad), var. *louckiana*, Jones, or, as I am now inclined to term it, *L. louckiana*†. It is $\frac{7}{16}$ inch long by $\frac{5}{16}$ high. This species was first found in the Bird's-eye Limestone.

On an unnumbered piece of rock from the same locality is

* A somewhat similar Leperditioid fossil, but characterized by an angular process at one end of the dorsal border, is the *Cythere sublævis*, Shumard, Swallow's Report Geol. Surv. Missouri (Preliminary Report on some of the principal Mines in Franklin, &c., Missouri), 1855, pt. 1, p. 116, and pt. 2, p. 195, pl. B. fig. 15. This little fossil is said to belong to "the Calciferous Sandrock under the Trenton Limestone," having been found in the "1st Magnesian Limestone," near its junction with Saccharoidal Sandstone, near Hamilton Creek, St.-Louis County, Missouri."

† It seems to me quite probable that the several apparently varietal forms of these and allied Entomostraca had sufficient permanence over wide areas and during long periods to satisfy the requirements of a "species;" and as they are distinct enough to be catalogued as separate types and may have had important modifications in their soft parts, they can conveniently be entered as "species," avoiding the repetition of dual terms.

a specimen apparently the same as "639," but much buried on the dorsal border.

"634." Various specimens of larger or smaller individuals, much like those in "639," "Murray Bay."

"634," "55" on blue label, and "927." From the same locality.

Leperditia, near *L. louckiana*, Jones; together with small forms, probably *Primitiæ*.

On a tablet without a number: "Black River, Pointe Claire."

Leperditia louckiana, Jones, near to "639," larger than "635;" $\frac{3}{16}$ inch long, about $\frac{1}{8}$ high.

Without a number: "*Leperditia*, Black River, Pointe Claire." *Leperditia louckiana*?

3. *Leperditia josephiana*, Jones.

Leperditia canadensis, var. *josephiana*, Jones, Ann. & Mag. Nat. Hist. 1858, ser. 3, vol. i. p. 341; Geol. Surv. Canada, 1858, dec. iii. p. 94, pl. xi. fig. 16.

Leperditia fabulites (Conrad), var. *josephiana*, Jones, Ann. & Mag. Nat. Hist. 1881, ser. 5, vol. viii. p. 344, pl. xix. fig. 7, pl. xx. figs. 7, 8, and p. 345, pl. xx. fig. 4?

Specimens in the McGill University Museum. Labelled "55" on yellow label, and "927," "Murray Bay, Trenton?" A dark grey fine-grained limestone.

Leperditia fabulites, Conrad, var. *josephiana*, Jones, or, as I now prefer to call it, *L. josephiana*, Jones. Eye-spot very feeble; valve $\frac{3}{8}$ inch long, $\frac{2}{8}$ high.

L. josephiana has been found in the "Trenton Limestone."

"55*" on yellow label, and "927." The same locality. Dark grey limestone, with valves and carapaces on bed-plane and scattered throughout.

Leperditia josephiana, Jones. Valves $\frac{4}{16}$ inch long and $\frac{3}{16}$ high.

Together with a broader (higher) form, *L. louckiana?*, smaller than "639."

4. *Leperditia anticostiana*, Jones.

Leperditia canadensis, var. *anticostiana*, Jones, Ann. & Mag. Nat. Hist. 1858, ser. 3, vol. i. p. 341; Geol. Surv. Canada, dec. iii. 1858, p. 95, pl. xi. fig. 17.

Leperditia fabulites (Conrad), var. *anticostiana*, Jones. Ann. & Mag. Nat. Hist. 1881, ser. 5, vol. viii. p. 344, pl. xix. fig. 8.

In the McGill University Museum. Labelled "1125."

" *Leperditia anticostiana*, Jones. Upper Silurian; Anticosti." This is $\frac{3}{8}$ inch long, $\frac{2}{8}$ high.

L. anticostiana belongs to the "Hudson-River group."

5. *Leperditia fabulites* (Conrad).

Cytherina fabulites, Conrad, Philad. Acad. Nat. Sci. Proceed. 1843, vol. i. p. 332.

Leperditia fabulites, Jones, Ann. & Mag. Nat. Hist. 1856, ser. 2, vol. xvii. p. 89; 1858, ser. 3, vol. i. p. 146; 1881, ser. 5, vol. viii. pp. 342–4.

Leperditia fabulites, Whitfield, Report Geol. Wisconsin, vol. i. (1883) p. 160, fig. *j*.

In the McGill University Museum. Labelled "61." "Trenton." No locality mentioned.

A narrow left valve (the left is always the smaller valve, overlapped on the ventral edge), $\frac{2}{8}$ inch long and $\frac{3}{16}$ high.

Leperditia, probably *L. fabulites*, Conrad. This species belongs to the "Trenton group."

L. fabulites is stated to be abundant among the Trenton fossils of Mineral Point and elsewhere in Wisconsin ('Report Geol. Wisconsin,' vol. ii. 1877).

Note.—"*Cytherina* indeterm.," Hall, Palæont. New York, 1847, vol. i. p. 44, pl. x. fig. 12; from the "Bird's-eye Limestone," and said to be similar to one from the "Trenton Limestone," may be *L. fabulites* (Conrad).

6. *Leperditia amygdalina*, Jones.

Leperditia amygdalina, Jones, Ann. & Mag. Nat. Hist. 1858, ser. 3, vol. i. p. 342; Geol. Surv. Canada, dec. iii. 1858, p. 97, pl. xi. figs. 18, 19; Ann. & Mag. Nat. Hist. ser. 5, vol. viii. 1881, p. 344, pl. xix. fig. 9.

In the McGill University Museum. Labelled "594." Chazy Limestone. A slab of black limestone with the hollow insides of numerous valves showing on a bed-plane; their edges are broken off. Some valves are scattered about in the substance of the slab. The valves, about $\frac{1}{6}$ inch long, seem to belong to *Leperditia amygdalina* (?), Jones.

"603." "*Leperditia*, Chazy, McNab," Ontario, Upper Canada. In dark grey limestone composed of tests, about $\frac{1}{6}$ inch long. *L. amygdalina* (?), Jones.

7, 8. *Leperditia alta* (Conrad), et *L. Jonesi*, Hall.

Cytherina alta, Conrad, in Vanuxem's Geol. Report New York, 3rd District, 1842, p. 112, fig. 23, no. 6; Hall, Palæontol. N. York, 1852, vol. ii. p. 338, pl. lxxviii. fig. 2, *a, b, c, d*.

Leperditia alta, Conrad, sp. (?), Jones, Ann. & Mag. Nat. Hist. 1856, ser. 2, vol. xvii. p. 88, pl. vii. figs. 6, 7; 1858, ser. 3, vol. i. p. 250, pl. x. figs. 8, 9.

Leperditia alta et *L. Jonesi*, Hall, Palæontol. New York, vol. iii. 1859, pt. 1, pp. 372, 373.

Leperditia alta, Meek, Report Geol. Surv. Ohio, vol. i. pt. 2, Palæontology, 1873, p. 187, pl. xvii. figs. 2, *a*, *b*.

Leperditia alta, Jones, Ann. & Mag. Nat. Hist. 1881, ser. 5, vol. viii. p. 346.

Leperditia alta, Whitfield, Report Geol. Wisconsin, vol. iv. 1882, p. 323, pl. xxv. figs. 8, 9, and vol. i. 1883, p. 198, fig. *e*.

At page 346 of the Ann. & Mag. Nat. Hist. for November 1881, noting *L. alta*, and referring to the usual association of relatively large and small valves (in Ohio, New-York State, Canada, and the Arctic regions), I mentioned that Dr. James Hall (recognizing his figs. 2 *b* and 2 *c* as both right valves) has proposed to distinguish the larger form as *L. Jonesi*. The first name would seem to be more applicable to the larger (fig. 2 *c*) than to the smaller form (fig. 2 *b*); but probably Dr. Hall has good reason for his decision. In this case my figs. 6 *a*, 6 *b*, pl. 7, February 1856, are probably *L. Jonesi*, Hall; and so may Meek's fig. 2 *a* of a specimen from the Helderberg group, Greenfield, Ohio. A specimen of "*L. Jonesi*" (from the Waterlime of the Lower Helderberg) in the American Museum of Natural History at New York, I have observed to have not only a reticulate muscle-spot, but also to be somewhat *gibberous* on the postero-dorsal margin of the left valve. This feature is shown to a slight extent on the small left valve (fig. 7 *a*, pl. 7, February 1856), and may well exist in the left valve of the larger form, as it is not uncommon on the left (smaller) valve of several *Leperditiæ*, such as *L. fonticola*, Hall, from Wisconsin*, and *L. britannica*, Rouault, from Brittany and Normandy. In *L. faba*, Hall, from Indiana, the dorsal swelling on the left valve appears to be on the anterior and not on the hinder portion †.

In the McGill University Museum. Labelled "573." "*Leperditia alta*" (Conrad), Am. Mus. Nat. Hist. Lower Helderberg Group, Tentaculite Limestone, Schoharie, N. Y.

In a very dark grey limestone full of Tentaculites &c. are some imperfect specimens. The best of them appears to belong to the larger form (*L. Jonesi*) of the two usually associated together in the Lower-Helderberg rocks. *L. alta* occurs also in an equivalent formation in Pennsylvania.

* *Leperditia fonticola*, Hall, Twentieth Ann. Rep. Regents Univ. N. Y. &c. revised edit. 1870, p. 428, pl. xxi. figs. 1–3. "In limestone of the Niagara Group, near Fond-du-Lac, Wisconsin." *L. fonticola* is said to be abundant in the Niagara Group at Byron, Wisconsin ('Rep. Geol. Wisconsin,' vol. i. 1883, p. 187).

† Twenty-seventh Ann. Rep. Reg. Univ. N. Y. &c. 1875–6, pl. xxxii. figs. 1–3, with *Beyrichia granulosa*, Hall, fig. 4, both from the Niagara Group of Central Indiana. (No descriptive text.)

Prof. Whitfield figures and describes the (apparently) smaller of the two forms above referred to, finding it abundant in the Onondaga Salt Group (Lower-Helderberg ?, Chamberlin), at Waubakee, Wisconsin.

9. *Leperditia cylindrica* (Hall, 1852).

Cytherina cylindrica, James Hall, Palæontology of New York, 1852, vol. ii. p. 14, pl. iv. figs. 8 *a*, 8 *b*.

Leperditia (*Isochilina*) *cylindrica* (?), Jones, Ann. & Mag. Nat. Hist. 1858, ser. 3, vol. i. p. 253.

Isochilina cylindrica (?), ibid. p. 255, and Geol. Surv. Canada, dec. iii. p. 101.

[Not the *L.* (*Is.*) *cylindrica*, Hall, 1872, 24th Annual Report N. Y. State Mus. N. H. p. 231, pl. viii. fig. 12; and Report Geol. Surv. Ohio, vol. ii. part 2, 1875, p. 101, pl. iv. fig. 5. This may be a *Primitia*.]

Specimens in the McGill University Museum. Labelled "1098." "*Leperditia cylindrica* (Hall). Medina Sandstone, Medina, N. Y."

This is a real *Leperditia*, in sandstone with *Lingula cuneata*.

The specimens vary in size; some are $\frac{15}{60}$ inch long and $\frac{8}{60}$ high, others are smaller. Some in the Geological Society's collection are $\frac{5}{20}$ inch long and $\frac{3}{20}$ high.

We have now some individuals of this species in the "Medina Sandstone" of Medina, N. Y., associated with *Lingula cuneata*, sufficiently well preserved, though merely casts, to show that they really belong to *Leperditia*, and not to *Isochilina*. In the Ann. & Mag. Nat. Hist. for April 1858, p. 254, I suggested that this was comparable with a small Russian form figured in Ann. & Mag. Nat. Hist. ser. 2, vol. xvii. pl. vii. figs. 11–13, which I then thought might be the young *L. marginata* (Keyserling), but which is now regarded as the *Isochilina punctata* (Eichwald), see Ann. & Mag. Nat. Hist. ser. 5, vol. viii. pp. 346, 347. The *large* valve formerly referred by me to *L. marginata* (Keyserl.) is the *Isochilina grandis*, Jones (Ann. & Mag. Nat. Hist. ser. 5, vol. ix. p. 171).

L. cylindrica (Hall) has been found in the "Medina Sandstone" of Oneida and Niagara Counties, N. Y.

Genus Isochilina, Jones.

1858. Subgenus, Jones, Ann. & Mag. Nat. Hist. ser. 3, vol. i. p. 248.
1858. Subgenus, Jones, Geol. Surv. Canada, dec. iii. p. 97.
1870. Genus, Jones, Monthly Microsc. Journ. Oct. 1870, pp. 187, 191.
1872. Genus, Barrande, Syst. Silur. Bohême, part 1, Suppl. to vol. i. p. 533.

1873. Genus, Schmidt, Mém. Acad. Imp. Sci. St.-Pétersb. sér. 7, vol. xxi. no. 2, pp. 9, 21.
1881. Genus, Jones, Ann. & Mag. Nat. Hist. ser. 5, vol. viii. p. 346, vol. ix. p. 171.

Isochilina ottawa, Jones.

Leperditia (Isochilina) ottawa, Jones, Ann. & Mag. Nat. Hist. 1858, ser. 3, vol. i. p. 248, pl. x. fig. 1; Geol. Surv. Canada, dec. iii. 1858, p. 97, pl. ix. fig. 14.

Specimens in the McGill University Museum. Labelled "595." "*Leperditia*, 5 miles west of L'Orignal." Chazy Limestone.

This is *Isochilina ottawa*, Jones; in dark grey limestone composed of these tests. Some are shorter and higher than others. The eye-spot is feebly marked in general, but stronger in some individuals. The valves vary from $\frac{1}{5}$ inch in length to $\frac{1}{6}$ long and $\frac{1}{10}$ high and $\frac{1}{5}$ long and $\frac{1}{9}$ high.

Isochilina ottawa was first got from the Chazy Limestone at L'Orignal and from the Calciferous Sandrock at Granville.

"881." On this large slab of *Isochilina*-Limestone the *Isochilina ottawa* is larger ($\frac{1}{4}$ inch long), with stronger eye-spot and with a feeble muscle-spot.

Genus Primitia, Jones and Holl, Ann. & Mag. Nat. Hist. 1865, ser. 3, vol. xvi. p. 415.

Beyrichiæ simplices, Jones, Ann. & Mag. Nat. Hist. 1855, ser. 2, vol. xvi. p. 85.

Primitia leperditioides, Jones.

Beyrichia Logani, Jones, var. *leperditioides*, Jones, Ann. & Mag. Nat. Hist. 1858, ser. 3, vol. i. p. 244, pl. ix. fig. 10; Geol. Surv. Canada, dec. iii. 1858, p. 91, pl. xi. figs. 1–5.
Primitia Logani, Jones, var. *leperditioides*, Jones, Ann. & Mag. Nat. Hist. 1865, ser. 3, vol. xv. p. 416.

In the McGill University Museum. Labelled "635." "*Leperditia*, Trenton (B. R.), Pointe Claire."

Small black carapaces and valves in a dark grey limestone with ferruginous bed-plane and some marly seams. The limestone is largely composed of these tests, with Polyzoa &c. This is not a *Leperditia*, but *Primitia Logani*, Jones, var. *leperditioides*, Jones, or, preferably, *P. leperditioides*, Jones.

It is $\frac{1}{12}$ inch long, $\frac{1}{20}$ inch high.

P. leperditioides was originally obtained from the "Calciferous Sandrock" of Grenville.

Table of the Distribution of the Silurian Leperditiæ,

	Arctic Regions.		Newfoundland.	Canada.
	Wellington Strait.	Beechey Island.		
Lower Helderberg Group (Tentaculite Limestone, formerly included in the Water-lime group).	Leperditia arctica, *J.*	L. gibbera, *J.*	....	....
Coralline Limestone of Schoharie (Niagara Group?).	....	....	....	....
Onondaga Salt Group.	....	....	....	....
Clinton Group ...	....	....	....	....
Medina Sandstone	....	....	....	....
Oneida Conglomerate.				
Hudson-River Group	....	....	....	L. anticostiana, *J.*
Utica Slate				
Trenton Limestone	....	....	....	L. fabulites, *C.*; L. josephiana, *J.*; L. pauquettiana, *J.*; L. Billingsii, *J.*; L. louckiana, *J.*?
Black-River Limestone	....	....	....	L. louckiana, *J.*
Bird's-eye Limestone	....	....	....	L. louckiana, *J.*; Isochilina gracilis, *J.*
Chazy Limestone. .	....	....	....	L. canadensis, *J.*; L. amygdalina, *J.*; Isochilina ottawa, *J.*
Calciferous Sandrock	....	....	....	L. canadensis †, *J.*; L. Anna, *J.*; Is. ottawa, *J.*; Primitia leperditioides, *J.*
Quebec Group ...	....	....	L. turgida, *Billings*; L. concinnula, *B.*; L. ventralis, *B.*‡	
Potsdam Sandstone	....	....	Primitia? atlantica, *B.* 1874; P. simplex, 3 varr., *J.* 1881.	

* There are several published forms which may prove to be *Primitiæ*
† *Leperditia bivia*, C. A. White, 1874, seems to be closely allied to
‡ These three forms are near allies of *L. canadensis.*

Isochilinæ, *and* Primitiæ * *in North America.*

State of New York.	Wisconsin.	Ohio.	Indiana.	Pennsylvania.	Tennessee.
L. alta, *C.*; L. Jonesi, *Hall*; L. gibbera, var. scalaris, *J.*	....	....	....	L. gibbera, var. scalaris, *J.*	
L. alta, *C.*; L. Jonesi, *H.*	L. fonticola, *H.*	L. alta, *C.*; L. Jonesi, *H.*	L. faba, *H.*	L. alta, *C.*	
....	L. alta, *C.*				
....	....	....	....	L. pennsylvanica, *J.*	
L. cylindrica, *H.*					
....	L. fabulites, *C.*	....	....	....	L. josephiana, *J.*
L. fabulites?, *C.*	....	....	....	L. ovata, *J.*	

not included here, besides some small, obscure, and, as yet, undetermined *Primitia*-like fossils.
L. canadensis, var. *labrosa*.

XLIII.—*Description of a new Species of the Coleopterous Family* Cetoniidæ *from Madagascar.* By CHAS. O. WATERHOUSE.

Stenotarsia punctiventris, n. sp.

Nigra; thorace sanguineo, maculis duabus nigris, scutello sanguineo; elytris obsolete striato-punctatis, sanguineis, singulo macula parva discoidali nigra. ♀. Long. 6 lin.

Head velvety black; clypeus shining, closely and rather strongly punctured, the apex distinctly and acutely incised. Thorax narrower than the elytra, more convex than in its allies, somewhat circular in outline, very slightly narrowed at the anterior angles, which are not produced; the margins not incrassate, fringed with black hair. On the disk behind the middle are two small, round, widely separated, black spots. Scutellum rather large, nearly an equilateral triangle. Elytra somewhat depressed, slightly narrowed towards the apex, the apical callosity very obtuse. Each elytron has four somewhat irregular indistinct lines of punctures, and on the disk a round black spot, placed a little nearer to the suture than to the side, and a trifle nearer to the base than to the apex. Sides of the metasternum and of the abdomen rather strongly vermiculate-punctate. Legs robust, strongly punctured. Pygidium moderately convex, about one quarter broader than long, opaque, rounded at the apex, the apical margin narrowly reflexed and shining; the rest of the surface is moderately thickly but obscurely punctured. Anterior tibiæ rather broad, armed with two teeth, *i. e.* one besides the apical projection.

This species most nearly resembles *Stenotarsia Scottii*, Janson, in general form, but the black spots on the elytra are differently placed. It is possible that it may be *S. crocata*, G. & P. (known to me only from description); but in that case the expression "clypeo parum exciso" is very misleading, as the clypeus is much more incised than in the allied species. The legs are more robust.

Hab. Madagascar.

Dr. Kraatz places *S. Scottii* in his genus *Linotarsia*, with *S. discoidalis* and *S. picta*, Waterh. As the genus *Linotarsia* is separated from *Stenotarsia* chiefly on account of the form of the thorax, I am rather at a loss to understand why these three species are associated, *S. discoidalis* having the thorax narrowed in front with porrect anterior angles. *S. Scottii* has the thorax almost circular; and *S. picta* has it constricted before the base, with diverging posterior angles.

Dr. Kraatz also mentions that "besides the build of the thorax *Linotarsia* is distinguished from *Stenotarsia* by the 3- (not 2-) toothed anterior tibiæ."

S. discoidalis and *S. picta* have three acute teeth in both sexes; but in *S. Scottii* (and *S. plagiata* more recently described by myself) the anterior tibiæ are only two-toothed in the male, the would-be basal one being so obscure as to be scarcely noticeable. In *S. punctiventris* here described, the anterior tibiæ have no trace of a third tooth, although the specimen is a female; I therefore place it in the genus *Stenotarsia*, although the form of the thorax &c. is that of "*Linotarsia Scottii.*"

XLIV.—*On a Polythalamian from the Salt-pools near Déva in Transylvania.* By Dr. EUGEN VON DADAY *.

THE Protozoa of the numerous salt-ponds and pools in Transylvania were first studied, and compared with the Protozoan fauna of the sea and of fresh waters, by Prof. Géza Entz. It was found that "the Infusorian fauna of Transylvanian salt-pools, which cannot well be styled rich in comparison with that of the fresh waters, (1) possesses some new forms which have hitherto been found neither in fresh nor in sea water; (2) a portion of the Infusoria of the salt-pools has not previously been found in freshwater, but only in the sea; (3) the greater part of the Infusoria of the salt-pools is formed by those forms which occur both in fresh water and in the sea; and (4) only about a fourth part of the Infusoria found consists of forms which have not hitherto been found in seawater"†. Lastly, however, it is stated that the Infusorian fauna of the continental salt-pools stands in closer relation to that of the sea than to that of the fresh water ‡.

Among the thirty-seven Infusoria (Ciliata) enumerated in two memoirs § by the above-mentioned naturalist from the salt-pools of Torda and Szamosfalva, eight species (*Acineta tuberosa*, Ehr.; *Phacus striatus*, Cohn; *Lacrymaria lagenula*, Clap. & Lachm.; *Aspidisca polystyla*, Stein; *Styloplotes*

* Translated by W. S. Dallas, F.L.S., from the 'Zeitschrift für wissenschaftliche Zoologie,' Band xl. pp. 465–480. (See a preliminary note in 'Annals,' vol. xiii. p. 307.)

† 'The Infusorian Fauna of the Salt-pools of Torda and Szamosfalva' (in Hungarian), 1876, pp. 9, 10.

‡ *Loc. cit.* p. 10.

§ "On some Infusoria of the Salt-pool at Szamosfalva" (in Hungarian), Naturhistorische Hefte, Bd. ii. pp. 219–258, Taf. viii., x.; (in German), *ibid.* Bd. iii. pp. 33–72.

appendiculatus, Stein; *Uronychia transfuga*, Stein; *Euplotes Harpa*, Stein; *Oxytricha gibba*, Duj.) are exclusively marine forms; fourteen species (*Loxophyllum lamella*, Ehr.; *Loxophyllum fasciola*, Ehr.; *Amphileptus anaticula*, Ehr.; *Cyclidium glaucoma*, Ehr.; *Pleuronema chrysalis*, Ehr.; *Condylostoma patens*, Duj.; *Chilodon cucullulus*, Ehr.; *Aspidisca lynceus*, Ehr.; *Aspidisca turrita*, Ehr.; *Euplotes charon*, Ehr.; *Stylonychia pustulata*, Ehr.; *Metopus sigmoides*, Clap. & Lachm.; *Vaginicola crystallina*, Ehr.; *Cothurnia imberbis*, Ehr.) occur both in fresh waters and in the sea; two genera (*Chanostoma margaritiferum* and *Sparotricha vexillifer*), three species (*Holophrya gulo*, *Chlamydodon cyclops*, and *Ervilia salina*), and four varieties (*Cothurnia imberbis*, var. *curvula*, *Vaginicola crystallina*, var. *annulata*, *Vorticella microstoma*, var. *halophila*, and *Vorticella nebulifera*, var. *salina*) are new; and the Infusoria which have hitherto been known only out of fresh waters are represented only by six species (*Enchelys nebulosa*, Ehr.; *Cyrtostomum leucas*, Stein; *Cinetochilum margaritaceum*, Ehr.; *Glaucoma scintillans*, Ehr.; *Halteria grandinella*, Ehr.; and *Stichotricha Mülleri*, Lachm.).

Of Rhizopoda the following were found in the salt-pool of Szamosfalva:—*Pleurophrys helix*, Entz; *Plectophrys prolifera*, Entz; *Euglypha pusilla*, Entz; *Microcometes tristripetus*, Entz; *Orbulinella smaragdea*, Entz; *Ciliophrys infusionum*, Cienk.; *Amœba guttula*, Duj.; *Amœba limax*, Duj.; *Amœba princeps*, Ehr.; *Amœba diffluens*, Ehr.; *Amœba radiosa*, Ehr.; and *Podostoma filigerum*, Clap. & Lachm.* The general character of the Rhizopod-fauna of the salt-pool may be summed up as follows:—"On the whole, the salt-pool is poor in Rhizopod-forms; those forms occur in greatest number which, while they are very common in fresh water, are probably to be reckoned in the series of those organisms which occur both in fresh and in sea water; among the comparatively numerous forms peculiar to the salt-pool the specific allies of two (*Euglypha pusilla* and *Microcometes tristripetus*) have hitherto been found only in fresh water, while the nearest relative of another species (*Pleurophrys Helix*) lives in sea water; of two new genera (*Plectophrys* and *Orbulinella*) one (*Orbulinella*) is allied to the marine Foraminifera with perforated shells; and, finally, it may be noted as a negative character, that the *Arcellæ*, so numerous in fresh waters, and which are so easy to find that one can see them with the naked eye, as well as the *Difflugiæ*, which are equally abun-

* "Ueber die Rhizopoden des Salzteiches zu Szamosfalva," Naturh. Hefte, Bd. i. Heft 6, Taf. ix., x. (in Hungarian), pp. 185–199 (in German).

dant in fresh waters, are entirely wanting in the salt-pool as in the sea*.

The following pages are intended to furnish a further contribution to the knowledge of the Rhizopoda of the saline inland waters, and further to establish the proposition *that the Protozoan fauna of these waters presents remarkable agreements with the marine fauna.*

Having been occupied for some years with the study of the Crustacea of Transylvania, I made collections in August of last year in the salt-pools near Déva (in the south-western angle of Transylvania). On examining the results of my collections preserved in alcohol, I found, to my great astonishment, among the Copepoda, a great number of empty shells of a Polythalamian, which at once engrossed all my attention. In order to convince myself that the empty shells were derived from a still living Polythalamian, I repeatedly had sent to me in the course of this summer water from the above-mentioned salt-pools, and in this the shells constantly occurred, among the filaments of Algæ, in the mud, and floating at the surface. Unfortunately the shells were generally empty, only a few of them containing the protoplasmic body in some chambers, and I was unable to observe the interesting Polythalamian (probably the first representative of the whole order not living in the sea) in a state of vital activity.

According to the literature on living and fossil Polythalamia accessible to me, the Polythalamian of the salt-pools at Déva represents a new genus, which I shall name *Entzia*, in honour of my esteemed teacher.

The characters of the genus may be summarized as follows:—

The many-chambered chitinous shell is not perforated and contains imbedded siliceous lamellæ in great abundance. The spirally arranged chambers together form a shell wound from right to left, like the shell of a flat *Helix*. The chambers are entirely visible only from the convex side; on the concave side they cover one another, so that on the apical surface all the chambers are visible, but on the basal surface only those of th· last whorl. On the outer partition of the last chamber there are two large, oval, tubularly produced apertures and two smaller circular ones, and these are repeated upon all the septa.

Species:—*Entzia tetrastomella*, with the characters of the genus.

* Naturh. Hefte, Bd. i. Heft 4, p. 199.

Morphology and Chemical Composition of the Shell.

The form of the shell, as already remarked, may be compared to that of the shell of a flat *Helix*, the whorls of which are coiled from left to right. In this respect our Polythalamian agrees with the genus *Rotalia*, belonging to the family Globigerinæ, Carp.; but while in the *Rotaliæ*, as Max Schultze remarks, specimens coiled to right and left are equally abundant*, I found the direction of the whorls in all specimens constantly from left to right. Consequently *Entzia* belongs to that series of forms in which the chambers, according to Max Schultze, are arranged in a spiral—that is, the group Helicostegia, d'Orb.

The apical surface is always convex, that is to say, the first chamber is placed higher and the following ones gradually descend, so that the last chamber comes to be the lowest. The natural consequence of this arrangement is that the basal surface of the shell is somewhat concave, and therefore that a dorsal and a ventral surface may be distinguished, upon the former of which the whorls and chambers may all be clearly distinguished, while on the latter only the chambers of the last whorl are visible. The dorsal and ventral surfaces show themselves most distinctly when the shell is looked at from the edge; and in this respect our Polythalamian resembles the Rotalinæ and *Rosalina ornata*, d'Orb.

In fully developed specimens the chambers always form two complete whorls, and in each whorl there are eight chambers, according to which I am probably justified in setting the number of chambers of the developed specimens at sixteen. And this I may do the more positively because among the numerous specimens which I have passed in review I have not met with a single one with more, but very many with fewer, than sixteen chambers. Thus I have found specimens with 6, 10, 12, 13, and 14 chambers. The latter scarcely admit of any other interpretation than that they are to be regarded as young individuals in various stages of development, which would have subsequently become developed into individuals with sixteen chambers. The correctness of this notion seems to be decisively proved by the fact that the corresponding chambers of the individuals with 6, 10, 12, 13, 14, and 16 chambers are of almost exactly the same form and size.

The outer margin of the shell and of both whorls, as in the Rotalinæ, is slightly waved and sinuous, in consequence of the convexity of the individual chambers; in other respects the surface is quite smooth.

* 'Ueber den Organismus der Polythalamien,' p. 59.

The results of the measurement of ten individuals are brought together in the following Table:—

Measured shell No.	Number of chambers.	Greatest diameter of the shell in millim.	Transverse diameter of the first chamber of the second whorl.	Transverse diameter of the primordial chamber.	Transverse diameter of the last chamber.
1	16	0·34	0·08	0·04	0·16
2	16	0·42	0·08	0·04	0·18
3	16	0·34	0·08	0·04	0·16
4	14	0·28	0·08	0·04	0·11
5	14	0·28	0·08	0·04	0·11
6	13	0·24	0 08	0·04	0·102
7	13	0·22	0·08	0·04	0·1
8	12	0·2	0·08	0·04	0·08
9	10	0·18	0·08	0·04	0·08
10	6	0·08	0·08	0·04	0·03

From this Table it appears that the largest of the 16-chambered individuals measures 0·42 millim., and that the size of the shell gradually decreases in accordance with the diminution in the number of the chambers, so that the smallest 6-chambered shell measures only 0·08 millim. Further I may note that the transverse diameter of the first chamber of the second whorl in all the measured shells has the same length of 0·08 millim., and that the diameter of the primordial chamber measures 0·04 millim. in all the shells. The greatest variation naturally occurs in the transverse diameter of the last chamber; but in individuals with an equal number of chambers this is also equal, only one 16-chambered shell forming an exception, in which the last chamber possesses a length of 0·18 millim., measuring, of course, from the inner margin of the whorl to the outer wall of the chamber.

However, I did not make measurements only of the primordial and last chambers, but also of the other chambers, and from these it appeared that the corresponding chambers in all individuals possess nearly the same size, the variations being so minute as hardly to deserve mention.

The numbers furnished by the measurements, I think, are in favour of the assumption, which is *à priori* correct, that the 6-, 10-, 12-, 13-, and 14-chambered individuals can only belong to the developmental series of the 16-chambered specimens, and I do not hesitate in the least to express this opinion.

As regards the form of the chambers I may sum up as follows the results of my observations. The outline of the primordial chamber is always circular; this chamber appears to be perfectly round, at least its outer free surface decidedly represents a segment of a sphere. The second chamber is somewhat elongated; its anterior extremity (*i. e.* the one which is in contact with the primordial chamber) is conically pointed, while the posterior end is enlarged. All the following chambers form truncated triangles, of which the base is convex, while of the sides the one is curved inwards, the other outwards. Variations of form are frequent but insignificant. On the whole it may be said of the form of the chambers that it remarkably agrees with that of the chambers of *Rotalia veneta*, M. Sch., *Rotalia Freyeri*, M. Sch., and *Rosalina ornata*, d'Orb. (see Max Schultze, 'Ueber den Organismus der Polythalamien,' Taf. iii. figs. 1, 2, 4, 6, and 8).

The septa of the individual chambers are very characteristic of the genus, and agree in structure in all the chambers except the primordial one. The septum of the primordial chamber is not particularly developed, and only forms the corresponding completion of the rest of the wall of this chamber. The structure of the septum of all the other chambers is shown most distinctly by the anterior wall, that is to say, the operculum of the last chamber, when the shell standing on its edge is looked at from in front. We then see that the septum consists of two symmetrical halves, which meet together in the middle line like a roof, and to a certain extent seem to be independent portions of the shell. The whole septum is more or less convex—a condition which appears most distinctly in transverse sections.

My investigations led me to the conviction that the septa of the chambers, as in the Rotalinæ, are formed by two lamellæ, one belonging to the anterior, the other to the posterior chamber; but that in one species these lamellæ enclose no interseptal space, the boundary between the two lamellæ being indicated only by a sharp line. The rather thick septa thus formed are not perforated with fine pores any more than the other parts of the shell; but instead of these, two small round apertures and two larger oval ones are present, and these both morphologically and physiologically represent the fine orifices of the Rotalinæ and the other Polythalamia in general. By these four apertures the chambers are placed in communication with each other and the last chamber with the outer world.

The two smaller round apertures and two larger oval ones in the septa are extremely characteristic of our Polythalamian. Their position can be most certainly ascertained when the shell placed upon its edge is examined in front. In this position of the shell it is at once seen that the two smaller round apertures are situated close to the middle line of the septum in the neighbourhood of the outer half, while larger oval apertures are placed beneath the small ones. As in sectional views the corresponding apertures cover each other, when the shell is looked at from the side only two apertures, one smaller and one larger, are ever to be seen.

The edges of both kinds of apertures are prominent and drawn out tubularly, an important character which of course appears most distinctly when examined from the side; in this position of the shell we see upon each septum a more prominent tube, narrowing from the base, and a shorter one, the longer of which originates from the larger and the shorter from the smaller aperture, the anterior free extremity of each being marked by an annular thickening. In this respect *Entzia tetrastomella* approaches the Lagenidæ, the septal orifices of which, according to Bütschli, are produced into tubes *, but it differs from these in the form and number of the apertures.

I now pass to the finer structure and chemical composition of the shell, and may remark here that in this respect *Entzia* appears to be one of the most interesting Polythalamia.

The colour of the shell varies from lighter or darker yellowish to deep brown, but generally shows those brownish tints which so frequently occur in chitinous structures. The substance of the shell contains angular plates of various sizes and forms, placed close together and entirely imbedded in the foundation-substance, so that, notwithstanding their presence, the shell retains a smooth surface. On this account I regard it as probable that the angular plates are not foreign bodies deposited from without in the substance of the shell, but that they are secreted from the protoplasm and deposited in the shell-substance, and that therefore they never project beyond the surface of the shell. Consequently I adhere to the opinion of Max Schultze, Schneider, and Entz, according to which the siliceous plates of the *Difflugiæ* and *Pleurophryes*, as well as of *Polymorphina silicea*, M. Sch., are secreted from the protoplasm and incorporated with the substance of the shell.

The circumstance that the shell is not very brittle, but possesses a considerable amount of flexibility, as proved by variously bent and compressed empty shells, and, further, the great resemblance of the shell in composition, as also in

* Bronn's 'Klassen und Ordnungen des Thierreichs,' 2te Aufl. Bd. i. p. 197.

colour, to the shells of *Difflugia* and *Pleurophrys*, led me from the first to suppose that it consists of a chitinous foundation-substance, in which the little angular plates are imbedded. The application of reagents in part confirmed the correctness of this supposition. First of all concentrated hydrochloric acid was employed, and this caused no change, any more than solutions of potash and soda. The colour, form, and structure remained unaltered. These results prove in the first place that the angular plates do not consist of carbonate of lime, but of silica, like the exactly similar plates of the *Difflugiæ*, *Pleurophryes*, and *Polymorphina silicea*, M. Sch.; and in the second place that the foundation-substance does not consist of horny material, but most probably of chitine. Concentrated sulphuric acid was then employed. The shells, after lying for a long time in sulphuric acid heated to boiling, lost their density and became very thin and flexible; they did not, however, entirely dissolve, but the septa separated, so that the shell broke up into its individual chambers. From these results I think I am justified in asserting that the foundation-substance of the shell consists of a chitinous compound, which, however, is partially displaced by deposition of silica, and remains pure only in the septa, as is proved by the breaking up of the shell into separate chambers on the application of sulphuric acid.

The results just communicated I think sufficiently prove the correctness of the above-stated proposition, that even in the chemical structure of its shell *Entzia* is one of the most interesting of Polythalamia, inasmuch as it combines those peculiarities which separately characterize the chitinous and sandy-shelled Rhizopoda. Further, I may also state that in this respect it comes nearer to the *Difflugiæ*, *Pleurophryes*, and sandy-shelled marine Mono- and Polythalamia than to the Rotalinæ, with which the form of its many-chambered shell ranges it.

The Soft Body.

Of the soft body, the protoplasmic body, I can unfortunately say but little, as I could not observe the Polythalamian in full vital activity. I was unable to obtain specimens containing the protoplasmic body in an uninjured state, but I succeeded, by staining with carmine, at least in rendering the protoplasmic body distinctly visible in single chambers.

In a preparation of a twelve-chambered specimen the ninth chamber was quite filled with the stained granular protoplasm. In it an oval nucleus with two darker nucleoli was distinctly visible. It is particularly to be noted that I also found the nucleus in the ninth chamber, and consequently in one of the middle chambers, of the fully developed 16-chambered specimen, which agrees with the observations made by F. E. Schulze upon *Polystomella striatopunctata*, as that naturalist found the nucleus of the 30-chambered specimens of the *Polystomella* between the tenth and twentieth chambers, and therefore also in the middle chambers. It may be that other chambers also contain nuclei, but of this I could not convince myself with certainty.

I was no more successful in ascertaining the structure of the pseudopodia. As the shell, except on the septa, contains no visible pores, the pseudopodia will probably radiate from the four apertures of the last chamber; but it is not quite impossible that they may break through the substance of the shell elsewhere, as is affirmed of *Pleurophrys helix* by Géza Entz, who says:—"From the posterior rounded part of the body pseudopodium-like processes often issue, which, as in other Rhizopoda, attach the soft body to the shell; but in other cases such processes perforate the shell, and project far as rigid filaments. I have frequently also met with the same remarkable phenomenon, *i. e.* the perforation of the shell by pseudopodia in the freshwater *P. sphærica*, in which the pseudopodia radiate, as in an *Actinophrys*, from the whole surface of the shell!" *

As regards the reproduction, I can only state that I frequently met with forms such as are regarded by Max Schultze as the youngest forms of *Polystomella strigilata* †, and which must have formed part of the developmental series of *Entzia*.

Position in the System.

In order to settle the systematic position of *Entzia*, I compared it with the known Polythalamia; but as all the original works were not within my reach, I depend upon Bütschli's work.

From the detailed description above given it is clear that, according to the general form of its shell and the arrangement of the chambers, *Entzia tetrastomella* most closely approaches the subfamily Rotalinæ, which Bütschli characterizes in the following words:—"Shell depressed, spirally coiled, so that on the apical surface all the chambers, on the basal only those of the last whorl, are visible" ‡. Max Schultze also

* 'Naturhistorische Hefte,' Bd. i. 4, pp. 190, 191.

† *Loc. cit.* Taf. v. fig. 16.

‡ *Loc. cit.* p. 206.

says :—"The calcareous shell so formed of spirally arranged chambers, that it externally resembles the shell of a *Helix* or *Turbo*. The chambers visible only upon one, usually convex, side of the shell, concealed on the other side, which is less convex, plane, or concave" *. In this subfamily it seems to approach the genus *Rotalia*, but still more the genus *Pulvinulina*, with which it might easily be confounded; but it is distinguished by the fact that its shell, as above indicated, contains no pores, while, according to Max Schultze and Bütschli, these are always present in the above-mentioned and, indeed, in almost all other representatives of the family Globigerinæ of Carpenter. From the character of *Polymorphina silicea* given by Max Schultze, in which it is stated that the shell is apparently always solid, without fine pores, I believe that, notwithstanding the different form of its shell, *Entzia* is also allied to that species, and, indeed, chiefly because the shells of both contain siliceous plates.

If we further take into consideration that the shell of *Entzia* is not perforated by any fine pores, we cannot avoid thinking that it may be related to the Imperforata. In this group the genus *Trochammina*, cited in an appendix by Bütschli, might be mentioned, as we are told of it :—"The genus *Trochammina*, on the other hand, included a great number of mono- and polythalamous forms, differing remarkably in their forms, and only held together by the minute structure of their shell-walls. These are composed of fine sand-grains, which are so intimately united that the outer surface of the shell always appears smooth, nay, sometimes as if polished" †. Notwithstanding this remarkable agreement in the structure of their shells between the two genera, I must assert that *Entzia* is more distantly related to the Imperforata than to the Perforata, and, indeed, mainly on account of the structure of the septa of the chambers. In the description of the septa it has been stated that they are formed of two lamellæ, one belonging to the older, the other to the younger chamber, while the septum of the Imperforata is formed by a simple lamella. Upon this point, indeed, I have no personal knowledge, but I may be allowed to appeal to Bütschli, who says :—"In most cases this septum is formed, in the manner described, of a single shell-lamella, namely the continuation of the wall of the older chamber, that portion of the new chamber which rests against the old one, obtaining no special new wall, but being merely completed by the wall of the preceding chamber. This is the condition of things at

* *Loc. cit.* p. 58.

† *Loc. cit.* p. 196.

least throughout the polythalamous Imperforata and a great part of the simple Perforata. In the more highly developed forms of the latter division the septum, however, is strengthened by the wall of the new chamber taking part in its formation" *. In accordance with this *Entzia* cannot possibly be referred to the Imperforata, but it represents a form which, in consequence of the absence of pores and the structure of the septa, unites the two main groups, but nevertheless approaches more closely to the Perforata than to the Imperforata.

Let us now take into consideration the composition of the shell-walls and their apertures, and compare *Entzia* in this direction with the Perforata. In characterizing the Lagenidæ, Carp., Bütschli says, amongst other things:—"Aperture usually characteristic, somewhat tubularly produced" †, while of the group Globigerinæ, Carp., he remarks, "Aperture, in opposition to the Lagenidæ, usually fissure-like, and not tubularly produced" ‡. In accordance with this, our genus, by virtue of the structure of its septa, certainly very closely approaches the subfamily Rotalinæ in the group Globigerinæ, but is sharply distinguished by its tubularly produced aperture, whilst in this respect it approaches the Lagenidæ, from which again it is distinguished by its septa possessing not a single aperture, but four of them, and, indeed, two larger oval ones and two smaller round ones, a case which, so far as I know, is quite isolated.

As regards the constitution of the shell, we have already shown that in our Polythalamian it consists of a chitinous foundation-substance which is impregnated with silica; this foundation-substance farther contains angular siliceous plates of various forms and sizes. A similar constitution of the shell is, indeed, known in many Mono- and Polythalamia; but the composition of chitine and silica reminds one vividly of the *Difflugiæ* and allied Rhizopoda generally of fresh water. In this respect, indeed, our Polythalamian certainly comes near *Polymorphina silicea*, of which Max Schultze says:—"The shell is of a yellowish colour, characterized by numerous very irregular depressions, which do not perforate it, and consists, at least for the most part, of silica" §; but the shell of *Polymorphina* also seems to contain some lime, as indicated by Max Schultze's statement, "The quantity of calcareous salts that may be present with the silica can only be very small," &c. But with all this it cannot be said that *Entzia*, as regards the substance and structure of its shell, is far removed from

* *Loc. cit.* p. 45. † *Loc. cit.* p. 197.
‡ *Loc. cit.* p. 200. § *Loc. cit.* p. 61.

the Globigerinæ, as in characterizing this group Bütschli expressly remarks, "Mono- or polythalamous, chitinous, calcareous (hyaline), or sandy" *.

After all that has been said we may range *Entzia tetrastomella* with the sandy-shelled forms of the group Globigerinæ, and especially with the "arenaceous Rotalinæ" and the genus *Trochammina*, of which Bütschli remarks:—"This embraces polythalamous forms, rotaloid, trochoid, or nautiloid in their winding, which in their form in part so nearly approach the calcareous Rotalinæ &c. that we are much inclined to place them in the vicinity of the latter"†.

From these comparative remarks I think I shall not be mistaken in asserting that:—

1. *Entzia tetrastomella*, the only continental Polythalamian at present known, resembles, in the form of its shell, the Rotalinæ of the group Globigerinæ, Carp.
2. In the structure of its shell it agrees with the genus *Trochammina* among the imperforate Polythalamia.
3. The structure of its septa agrees with that of the perforate Polythalamia.
4. The structure of the orifices of its septa is that of the Lagenidæ, Carp.
5. The chemical composition of its shell resembles that of the *Difflugiæ* and also that of *Polymorphina silicea* and the genus *Trochammina*, and reminds us of the group of the Globigerinæ.

Finally I regard it as probable that *Entzia tetrastomella*, with some forms of the genus *Trochammina*, represents a group which unites the imperforate with the perforate Polythalamia; at the same time it forms a genus which, by the intermedium of the Rotalinæ and the genus *Trochammina*, closely unites the group of the Lagenidæ with that of the Globigerinæ.

In conclusion I will devote a few words to those Protozoa associated with which *Entzia* occurs in the salt-pools. I noticed the following species:—

1. *Amœba limax*, Duj.
2. *Pleurophrys helix*, Entz.
3. *Dactylosphæra polypodia*, M. Sch.
4. *Cyphoderia ampulla*, Ehr.
5. *Orbulinella smaragdea*, Entz.
6. *Euglena viridis*, Ehr.

* *Loc. cit.* p. 200. † *Loc. cit.* p. 196.

7. *Peranema trichophora*, Duj.
8. *Amphidinium operculatum*, Clap. & Lachm.
9. *Glenodinium cinctum*, Ehr.
10. *Acineta tuberosa*, Ehr.
11. *Strombidium sulcatum*, Ehr.
12. *Glaucoma scintillans*, Ehr.
13. *Cyclidium glaucoma*, Ehr.
14. *Chilodon cucullulus*, Ehr.
15. *Lionotus grandis*, Entz.
16. —— *fasciola*, Ehr.
17. *Euplotes charon*, Ehr.
18. *Oxytricha gibba*, Duj.
19. *Sparotricha vexillifer*, Entz.
20. *Cothurnia imberbis*, Ehr., var. *curvula*.
21. *Vaginicola crystallina*, Ehr., var. *annulata*.
22. *Vorticella microstoma*, Ehr.
23. —— ——, Ehr., var. *halophila*.
24. —— *nebulifera*, Ehr., var. *salina*.

The species cited, which can hardly give a complete picture of the Protozoan fauna of the salt-pool at Déva, may be divided into four groups, according to their known habitats.

1. *Species which have hitherto been found only in fresh waters.*

Cyphoderia ampulla, Ehr.
Euglena viridis, Ehr.
Peranema trichophora, Duj.
Glenodinium cinctum, Ehr.
Strombidium sulcatum, Ehr.
Glaucoma scintillans, Ehr.
Lionotus fasciola, Ehr.
Vorticella microstoma, Ehr.

2. *Species which occur both in fresh and saline inland waters and in the sea.*

Amœba limax, Duj.
Dactylosphæra polypodia, M. Sch.
Cyclidium glaucoma, Ehr.
Chilodon cucullulus, Ehr.
Euplotes charon, Ehr.
Vorticella nebulifera, Ehr.
Cothurnia imberbis, Ehr.

3. *Species which occur in saline inland waters and in the sea.*

Amphidinium operculatum, Clap. & Lachm.
Acineta tuberosa, Ehr.
Oxytricha gibba, Duj.

4. *Forms which have hitherto been found only in saline inland waters.*

Pleurophrys helix, Entz.
Entzia tetrastomella, gen. et sp. nov.
Orbulinella smaragdea, Entz.
Sparotricha vexillifer, Entz.
Lionotus grandis, Entz.
Cothurnia imberbis, Ehr., var. *curvula*.
Vaginicola crystallina, Ehr., var. *annulata*.
Vorticella microstoma, Ehr., var. *halophila*.
—— *nebulifera*, Ehr., var. *salina*.

The representatives of the first two groups are all very common species, of which I have nothing to say. The cilioflagellate *Amphidinium operculatum*, Clap. and Lachm., included in the third group, is, on the contrary, a very interesting form, which merits some notice. This species was discovered by Claparède and Lachmann in the Norwegian fjords, but then for a long time was not again met with. It is again mentioned by Stein in his quite recent monograph of the Cilioflagellata (Arthrodelous Flagellata) of the Baltic; and Prof. Entz has shown me sketches of this Cilioflagellate which he made in Naples, and, according to an oral communication, he found the species abundantly in the Bay of Naples. According to these data *Amphidinium operculatum* is a marine species, which gives a decidedly marine character to the Protozoan fauna of the salt-pool near Déva. Of this interesting species I will further state that my investigations convinced me that the so-called circlet of cilia consists of a spirally twisted flagellum, which possesses an undulating frill, the oscillations of which simulate the supposed cilia; the same character, as I have since learned, has also been demonstrated by Klebs in *Hemidinium nasutum*, *Gymnodinium fuscum*, and *Peridinium habulatum*, so that it seems to me very probable that the Cilioflagellata throughout do not possess a circlet of cilia.

In the fourth group *Entzia tetrastomella* is naturally the most interesting form. It is the only known Polythalamian which has been met with except in the sea*, and, together with *Amphidinium operculatum*, it speaks decidedly in favour of the proposition laid down by Prof. Géza Entz, according to which the Protozoa of the saline inland waters are more nearly allied to those of the sea than to those of the fresh waters. The other Protozoa of this group are species which

* [But see H. B. Brady, "On Brackish-water Foraminifera," Ann. & Mag. Nat. Hist. ser. 4, vol. vi. 1870, pp. 273-309.—W. S. D.]

have previously been found only in the salt pools near Torda and Szamosfalva in Transylvania.

On the whole the Protozoan fauna of the salt-pool near Déva agrees pretty well with that of the pools at Torda and Szamosfalva, but in *Entzia tetrastomella* and *Amphidinium operculatum* it has to show two species peculiarly characteristic of this pool.

BIBLIOGRAPHICAL NOTICES.

Vergleichende Morphologie und Biologie der Pilze, Mycetozoen und Bacterien. Von A. de Bary. Engelmann: Leipzig, 1884.

It may be said at once that no more welcome contribution could have been made to botanical science at the present time than Prof. de Bary's new book. Eighteen years ago, when he published the 'Morphologie und Physiologie der Pilze, Flechten und Myxomyceten,' students of these organisms were presented with a treatise embracing the whole field of a subject where were lying scattered abundant materials sorely in need of critical selection and arrangement. Of Prof. de Bary's special qualifications for the task it would not become me to speak; it is sufficient that they enabled him to produce a book which may be said, without the smallest fear of contradiction, to have given an impulse to the study amounting to a new departure in its history. This sowing of fresh seed has again yielded so fruitful a crop in the hands of many active workers that a new edition of the text-book has for some years been greatly wanted. The present work supplies the want, and testimony of the extent of the advance that has been made appears in the fact that it is in reality a new book, resembling the former, perhaps, more in the thoroughness, vigour, and fertile thought displayed in its pages than in the special treatment of the matter. During the interval between the two books there arose such an accumulation of material to be dealt with, and entangled with it so many points of controversy to be discussed, that not only a fresh treatment of the matter became necessary, but a limitation in some measure of the scope of the treatise. The physiology of fungal organisms has received so much notice in the general physiolgical works of Sachs and Pfeffer, and in the vast literature that has grown up on the subject of fermentation, that Prof. de Bary has rightly considered it expedient to deal with it less fully in the circumstances. But, as we are reminded in the preface, morphological treatises of great extent can scarcely now (and certainly not in the present instance) be satisfactorily produced without constant reference to the phenomena which are specially termed biological—the modes and the adaptations of life; and in dealing with these one necessarily comes in contact with purely physiological matters.

It was scarcely necessary to have Prof. de Bary's declaration of belief that Fungi and Bacteria resemble other organisms in their invariable origin from similar parents. The days of theories of the "spontaneous generation" of such forms of life are surely numbered, and this great deep broken up. The present utterance has been called forth by the recent reappearance in a new book of Béchamp's theory of "Microzymas." To actually demonstrate the absolute origination of a form of life has been the fascinating aim of many an investigator possessed with the idea, as the alchemist was possessed in his time with a like one. With the growth of investigation the field for such theories has been contracted "step by step to narrower ground and to smaller and smaller objects—from the simple unorganized substance to the organized minimum, the *atome structuré vivant*; otherwise to that region where one may still fish in troubled waters." As to what may be caught therein there is nothing to be said, but perhaps much to be doubted.

The book is divided into three parts, the first dealing with the Fungi proper, the second with the Mycetozoa, and the third with the Bacteria or Schizomycetes. The first part is subdivided into sections, the first of these treating of the general morphology of Fungi and containing admirable chapters on the histology, the segmentation of the thallus, and the development, structure, and germination of spores. The second section of the first part deals with the life-histories of the groups of Fungi, and sets out with an introductory chapter full of most significant and impressive elucidation of the grounds on which classification is built. The vastness of the array of facts and generalizations, retained with a firm and comprehensive grasp, is almost forgotten in the lucidity with which these are arranged and explained. The classification here adopted is virtually that published by Prof. de Bary in 1881, and then recognized as in full harmony with the state of mycological science. He here divides the Fungi proper into two categories, thus:—

I. *The Ascomycetes Series.*

1. Peronosporeæ (with Ancylisteæ and Monoblepharis).
2. Saprolegnieæ.
3. Mucorini or Zygomycetes.
4. Entomophthoreæ.
5. Ascomycetes.
6. Uredineæ.

II. *Groups diverging from the Ascomycetes Series or of doubtful Position.*

7. Chytridieæ.
8. Protomyces and Ustilagineæ.
9. Doubtful Ascomycetes (Saccharomyces, &c.).
10. Basidiomycetes.

Groups 1–4 are, from their approach to Algæ, classed together as Phycomycetes.

Of those in category II., 7 and 8 are to be regarded as standing in relationship to the Phycomycetes; 9 in relationship, of course, with 5; and 10 with 6.

When the above Table is converted into a linear series for use the groups therefore follow thus:—

1. Peronosporeæ.	5. Chytridieæ.
a. Ancylisteæ.	6. Protomyces and Ustilagineæ.
b. Monoblepharis.	7. Ascomycetes.
2. Saprolegnieæ.	8. Doubtful Ascomycetes.
3. Mucorini.	9. Uredineæ.
4. Entomophthoreæ.	10. Basidiomycetes.

In this order the groups are taken here in Chapter V., and a comparative survey is made of the life-histories of each, which are discussed in detail. It would be entirely beyond the scope of the present notice to enter upon an explanation of the motives which have led to the above classification, since to adequately appreciate the force of the case made out for it, Chapter IV. must be carefully studied, and I venture to think that no mycologist could well find more instructive reading. Those who are familiar with the advances made during the last eighteen years will at once recognize in it an embodiment of the author's well-known views and a conformity with the present general tendency on the subject of classification.

The third section of the first part deals with the physiology of the Fungi proper, and contains chapters on the phenomena of germination and vegetation, with a specially interesting treatment of parasites and saprophytes.

The second part is occupied with the Mycetozoa, Chapter VIII. being devoted to their morphology and IX. to their physiology. A very particular interest attaches not only to this group but to any publication Prof. de Bary may give us on the subject, when the excitement is recalled which was caused by the appearance of his study of these remarkable organisms twenty-five years ago. Nor will the reader be disappointed with the present discussion of the subject.

The third part, devoted to the Bacteria or Schizomycetes, also contains two chapters (X. and XI.), dealing respectively with the morphology and physiology of a group of fascinating interest to many—botanist and pathologist alike. The pathologist has had it all, or nearly all, his own way with them of late, and it is refreshing to find the subject treated by a botanist whose experience of such organisms and their allies is without doubt unrivalled. From these two chapters both classes of students of the Schizomycetes will learn much, and its lessons, it is to be hoped, will be taken to heart in the right quarter.

There is one impression which is to be obtained from a study of these pages, and it will occur to many as the chief one—the equality of the treatment throughout. Undoubtedly certain chapters, such as the fourth, containing the introduction to the comparative survey of the groups of Fungi, will strike one as eminently impressive and of special value; but from the nature of the subject and the necessary method of treatment, this follows as a matter of course. The intimate knowledge and unrelaxed grasp of detail is equal throughout, and inspires both confidence and admiration in one who seeks it for guidance through conflicting theories and obscure facts.

George Murray.

Our Insect Allies. By Theodore Wood. Small 8vo. Society for Promoting Christian Knowledge: London, 1884.

We have heard so much in times gone by of "insect enemies" that it is refreshing to find an author who is willing to be an advocate on the other side. Mr. Wood, indeed, in the little work before us, is, perhaps, inclined to go a little too far, and now and then unduly magnifies the possible benefits that we may receive from insects. But this is excusable in an advocate, and it has the further advantage of enabling the author to make his book much more of a general introduction to the study of entomology than it could otherwise have been. As a sketch of the history of some of the commoner insects it is well suited to foster a taste for entomology in young people, and will guide them safely in their earliest steps. Indeed, in one respect especially, it takes ground that we are glad to see occupied, for while starting as a description of some of the insect allies of man, its goes directly against that old-fashioned line of thought which is so common, in which every thing is measured from the human point of view. Mr. Wood, on the contrary, points out to his readers that the insects of which we complain as destroying or injuring our property have an existence quite independent of us, and that it is only what he terms the "unnatural conditions" introduced by civilization that have converted most of them into recognizable enemies.

The little book is pleasantly written and illustrated with numerous woodcuts, many of them pretty good, while others are certainly very poor.

MISCELLANEOUS.

Note on the Occurrence of some rare Foraminifera in the Irish Sea. By Charles Elcock.

Last spring I obtained a dredging of about four pounds of very tenacious mud from a point south-west of the Isle of Man, depth

70 to 75 fathoms. After careful washing I found it contained a considerable number of that rare Rhizopod, *Technitella legumen*, Norman. The tests are in very fair condition, but through over-washing many are broken up, and none were found with the coating of sand or mud which sometimes covers them. A very good figure of this Foraminifer was given in this magazine in 1878, and one with the arenaceous coating is given in the 'Challenger' Report, vol. ix. plate xxv.

Fragments of a spicular test have been found by me in three or four other dredgings from the Irish Sea, but this is the first instance in which perfect tests have occurred. I should be glad to learn whether any other observer has obtained it in Irish waters.

The same dredging also contained a number of the very rare *Lagena Hertwigiana*, Brady, of which a figure is given in the 'Challenger' Report, vol. ix. plate lviii., and description at p. 470. This makes the fourth locality from which this *Lagena* has been obtained, the depths at which the others occurred being respectively 155 fathoms (Raine Island), 2600 fathoms (south of Australia), and 150 to 200 fathoms (near Bergen, Norway). Very fine examples of *Hyperammina elongata*, *Reophax scorpiurus*, and *Haplophragmium pseudospirale* were common.

I may add that examples were submitted for confirmation to my friend H. B. Brady, who unhesitatingly identified them as named.

19 Hughenden Avenue, Belfast,
October 18, 1884.

On the Occurrence of a Process resembling Copulation in Comatula mediterranea. By Dr. C. F. Jickeli.

While I was occupied with this organism in the Zoological Institute at Graz I observed a process which, like that described by H. Ludwig in *Asterina gibbosa* *, showed the closest resemblance to a copulation, and which I will here communicate, as the statements of this nature with regard to Echinoderms seem to me to be very scanty.

Two specimens of this *Comatula*, which were observed for several days in a large aquarium, were found one morning seated close together, with the arms closely entwined. In the evening of the same day, therefore about twelve hours after the discovery of this condition of things, the two individuals were still united; but on the following morning, or twenty-four hours after the first observation, the union was dissolved.

Another still less expected process now commenced. The arms fell off simultaneously with the separation of the pinnules, and

* Zeitschr. f. wiss. Zool. Bd. xxxvii.

broke up into the individual joints. At last only the two oral disks remained.

The pinnules, when fished out, were in part filled with semen or covered with adherent ova in the *Blastula*-stage, so as to confirm the probable supposition that this entwining of the two individuals might be a process of fertilization.

The ova passed in the aquarium through a normal development as far as the *Pentacrinus*-stage. The two armless *Comatula*-calyces continued for some days to live in the aquarium, and were then killed for histological investigation.

This observation seems to support Studer's* supposition that, at least in many cases, the separation of the arms of many Asterida stands connected with the evacuation of the sexual products.—*Zoologischer Anzeiger*, no. 174, August 18, 1884, p. 448.

On the Organization of Anchinia. By M. N. Wagner.

Last winter I found at Naples in great abundance a phase of development of *Anchinia rubra* different from that described by Vogt, Kowalewsky, Barrois, and Corrotsyeff. As regards its general appearance, this phase is characterized by a regularly globular form of body, and, further, it did not possess that long caudal appendage which characterizes the form hitherto known.

This phase was agamic. Twice I met with individuals with a small stolon covered with buds; but this stolon differed essentially from that of the sexual form.

The nervous system of this phase presents two pairs of very strong nerves, which run towards the anterior and posterior apertures of the body, and to them I give the name of *anterior* and *posterior nerves*. These nerves are analogous to the nerves of *Doliolum* and *Ascidia*.

Besides these nerves the ganglion gives origin, at its posterior part, to the *epithelial nerves*, which terminate in the cells of the external and internal epithelium of the body; to a nerve running towards the olfactory organ (the issue of the hypophysary gland); and to a *pneumogastric nerve*, which ramifies in the endostyle, the vibratile bands, and the branchiæ. In its upper part the ganglion also gives off the nerves running towards the surface of the body. The two sides of the ganglion give origin to the nerves terminating in the epithelial cells. Lastly, the posterior part of the ganglion presents, besides the *posterior nerves*, the *cloacal nerves* and the nerves running to the *vibratile sac*, that is to say towards the sac in which the posterior extremities of the vibratile bands terminate. The termination of the nerves is excessively varied, which gives reason to suppose that the specialization of the organs here reaches a very high degree.

* Monatsbericht der Berlin. Akad. 1876.

Among the corpuscles of the general cavity of the body we find that two principal types predominate, which I propose to call *nutritive* or *plastic corpuscles* and *formative corpuscles*. The blood-corpuscles only present a slight modification of the former.

Certain facts lead us to think that the plastic corpuscles originate from the cells of the alimentary canal. In pathological cases, when an organ or one of its parts has been destroyed its restoration is effected by means of the plastic corpuscles.

The formative corpuscles may, in some cases, reconstruct or replace the terminations of the nerves.

The corpuscles which give origin to the buds differ by their very rapid motion and by the presence in their interior of small particles of crystalline form.—*Comptes Rendus*, October 13, 1884, p. 615.

On the Anatomy of the Tyroglyphi. By Dr. ALFRED NALEPER.

Digestive Apparatus.—The œsophagus enters the stomach about where the body is constricted by the divisional furrow which is characteristic of the *Tyroglyphi*. Its two posterior angles are continued into wide cæca, which lie on the two sides of the intestine and reach as far as the rectum. The intestine originates from the dorsal part of the stomach. It is divided into a globular section and the rectum. These two sections are united by a short and narrow tube, into which the urinary vessels open. Histologically, the intestinal canal consists of a delicate *tunica propria* and the epithelium; there is no intestinal muscular layer even in the rectum. The epithelial cells of the stomach are small and strongly convex at the upper end. In the cæca and also upon certain parts of the stomach they grow longer and clavate, and become filled with a finely granular secretion, which is only slightly stained by carmine. The epithelial cells of the intestine are pavement-like and covered with a cuticle. In the œsophagus there is no epithelial lining. The anal fissure is situated in a fold of the outer integument, and is supported by two narrow, fluted, chitinous plates, to which numerous muscular fibres are attached.

The *urinary vessels* have not previously been met with in the *Tyroglyphi*. They consist of two short tubes, placed on the two sides of the intestine, and opening in common into the upper part of the rectum. Their wall consists of a structureless *tunica propria* and of large, very convex secreting-cells, which have wide intercellular spaces between them. The product of secretion is finely granular, and consists of uric acid and urates—at least I detected these chemically in great abundance in the balls of excrement.

The *nervous system* is not, as hitherto supposed, a simple ganglion traversed by the œsophagus. There is rather in the *Tyroglyphi* also a separation of the central nervous system into a cordate supra- and a laminar infra-œsophageal ganglion. The two are closely united by broad and short commissures. The supra-œsophageal ganglion extends nearly to the divisional furrow, the lower one to close by the genital aperture. From the former originate the nerves for the forcipate chelæ and the palpi: the latter emits nerves for the buccal organs, and further on each side four nerve-trunks for the limbs, and posteriorly nerves into the abdomen. In structure the central nervous system of the *Tyroglyphi* agrees with that of the Arthropoda. The ganglion-cells are unusually small. The central substance presents a finely fibrous structure only under a very high power. It is an interesting fact that in the infra-œsophageal ganglion the ganglion-cell layer occurs only on the underside. The nerves are very transparent and abound in rounded nuclei.

The *female sexual organs* consist of two germ-glands situated on the two sides of the anal fissure. The two oviducts run at first side by side along the ventral surface nearly to the external genital aperture, then turn backwards, and afterwards make another curvature forwards. Before reaching the genital aperture, the two oviducts unite to form a vagina. The space above the two ovaries is occupied by a vesicle, first described by Robin, and interpreted by G. Haller as a seminal vesicle. This notion would be supported by the innumerable quantity of cells which I found in this vesicle imbedded in an albuminoid mass, and which, from their size and form, I must regard as seminal corpuscles. I have been hitherto unable to demonstrate with certainty any union between this vesicle and the oviducts, which would place its interpretation as a seminal vesicle beyond doubt. The wall of the female sexual apparatus consists of a delicate *tunica propria* and a variously formed epithelial layer. In the first part of the oviduct the cells are low and small; in the dilated terminal portion, on the contrary, large, nearly cubical, and without distinct limitation. The ova are by no means developed in follicles, which become constricted off and pass into the body-cavity, but they become differentiated on the periphery of a central nucleated protoplasmic mass (germ-magazine) by a portion of the common plasma becoming cut off into a distinct cell-body (ovicell) around an enclosed nucleus. The ovicells are surrounded by a distinct vitelline membrane. The germinal vesicle is round and clear; the vitellus at first finely granular. Subsequently strongly refractive vitelline vesicles make their appearance, which soon completely conceal the germinal vesicle. After the ovum has attained its definitive size and form, it becomes surrounded by a shell, which is furnished by the epithelial cells of the oviduct. The external genital organs are rather complex in structure. In the male, as in the female, they are covered by two membranous sacs, each of which conceals two suckers. These are hollow cones, of which the side walls are strongly chitinized. The sucking disk, on the contrary, is a soft thin membrane. To it is attached a muscular bundle which lies in the axis of the sucker, and serves to pull back the sucking-disk. Muscular fibres are attached to the lower margin of the sucking-cone and function as its retractors. Under the two membranous sacs in the female lie the paired supporting plates, which are irregularly D-shaped. They meet at their upper ends, while the lower ones diverge considerably. Beneath them lies a smaller pair of plates, united with them by a sort of hinge. On the protrusion of the vagina, which is furnished with numerous chitinous folds, the membranous sacs with the suckers and lateral supporting plates move aside, while the posterior pair of plates flap backwards. By these means a wide orifice for the passage of the vagina is produced, and this, in consequence of the flexibility of the supporting plates and their movable union, is further very dilatable.

As *male sexual organs* we find two germ-glands, one of which is situated behind the rectum in median line, and the other laterally. Like the ovicells, the spermatoplasts are also developed from a germ-magazine, the nuclei imbedded in a common plasmatic mass becoming the starting-points of their formation. The seminal corpuscles are very small, rounded cells. The *vasa deferentia*, which are densely packed with semen, are often much dilated and exhibit irregular inflations. The delicate walls of the male sexual apparatus and its great transparency are the reasons of its having hitherto been quite unknown or interpreted in the most extraordinary manner. As an accessory gland of the male sexual apparatus, we have to indicate a large glandular tube running in a curve at the margin of the abdomen, the efferent duct of which is dilated into a reservoir into which the seminal ducts open. In sexually mature animals this gland is greatly developed. Its secretory epithelium consists of large indistinctly limited cells, which furnish a finely granular secretion. As a copulatory organ, we find throughout a greatly developed and strongly chitinized penis, the form of which is very different in the different species, and which therefore promises to furnish an important specific character. In the male animal the outer supporting plates are amalgamated to form a pointed bow, which, during copulation, is bent backward. Upon it lies the penis, so that its free end is directed backward. The penis is a straight, beak-like, or S-shaped channel, which closes at the apex into a perfect tube. The bottom of the channel is perforated by a round aperture, into which opens the *ductus ejaculatorius*, which is partly chitinized.

The spaces between the organs are occupied by a connective tissue (*corpus adiposum*) formed by reticulated cells, passing on the one side into the connective coating of the organs, and on the other into the matrix of the chitinous envelope. Large quantities of fat and carbonate of lime are deposited in these cells. The fatty cells are distinguished by their large nuclei and the reticulate arrangement of the plasma.—*Anzeiger der k. Akad. Wiss. in Wien*, July 3, 1884, p. 134.

On the Luminosity of the Glow-worm (Lampyris splendidula). By M. Wilhelm Kaiser.

On June 26, 1884, I captured a particularly fine female specimen, 13 millim. long, of *Lampyris splendidula*, Linn. For the purpose of preparation I stupefied it with ether, cut off its head, opened the abdomen, pressed out several hundred eggs, and finally prepared the luminous organ by cutting out the luminiferous papillæ, together with the chitinous substratum and a portion of the ventral chain. The organ had previously shown no luminosity; but when I spread it out upon an object-slide furnished with a caoutchouc ring, and, in applying the glass cover, brought it somewhat into the shade, I observed that first one, then a second, and, lastly, the third and fourth luminiferous papillæ shone with a green light. I now applied two wires from a powerful galvanic battery to that part of the preparation where I believed there were still remains of nerves, but without thereby causing any alteration in the intensity of the light. I then closed the preparation by applying Canada balsam to the edges of the caoutchouc ring and fixing on a glass cover. After this closure the organ continued shining for a quarter of an hour. A quarter of an hour later I warmed the preparation to about 50° C. (=112° F.), and then the luminosity gradually became fainter, passing finally into a yellow flicker like that of touchwood, and then ceasing. I now opened the balsam closure again and moistened the preparation with a drop of water. The luminous organ then, in about five minutes, showed a faint green luminosity, and it is still shining, an hour after the dissection, with a dull green light.

I communicate this, as the current opinion, to be found even in the best works, is that with the death of the animal the luminosity ceases. This supposed fact, however, seems to sink into a mere supposition in presence of my observation, unless the luminous organ as such carries on an independent life for an hour after the death of the animal, and during this continues to shine, whilst the animal, when alive, has it in its power to shine or not. However, I leave it to experienced naturalists to repeat my experiment and to test its relevancy to the question whether it is the decomposition of a substance in the luminous organ or the so-called "transparent" cells in that organ that produce the light, or what other forces may come into play. I will only remark further that the luminosity of animals, like other cases of mimicry, seems to serve for protection, in order to deter other animals from devouring them at night; thus, if one seizes a non-luminous female glow-worm with a pair of forceps, it immediately begins to shine, as also when it is roughly dropped upon the ground.—*Anzeiger der k. Akad. der Wiss. in Wien*, July 3, 1884, p. 133.

THE ANNALS

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[FIFTH SERIES.]

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XLV.—*Description of an Impregnated Uterus and of the Uterine Ova of* Echidna hystrix. By Sir RICHARD OWEN, K.C.B., F.R.S., &c.

[Plate XIII.]

IN the 'Transactions of the Royal Society' for 1865 a description is given of the marsupial pouches of the *Echidna hystrix* and of a "mammary fœtus" found in one of the pouches; they form a pair, and differ not only in this respect, but in the absence of a nipple, from the single mammary pouch of the Marsupialia. Each pouch is small: the one from which the young *Echidna*, not more than 1 inch 10 lines in length, was taken seemed capable only of receiving the head and fore limbs*, the rest of the body being covered and concealed by the hair of the under surface of the parent's body.

As this specimen was captured on the 12th of August, 1864, I communicated to my friend George Frederic Bennett, Esq., Corresponding Member of the Zoological Society of London, then resident at Toowoomba, Queensland, that the months of July, August, and September would be most favourable for the capture of impregnated females of the spiny Monotreme.

* 'Anatomy of Vertebrates,' vol. iii. p. 767, fig. 603.

In 1880 I was favoured by receiving a female *Echidna*, killed August 30, 1879, in which the left uterus contained three ova; also a female *Echidna*, killed September 14, 1879, in which one ovum was contained in the right uterus. The female organs of both specimens are subjects, figs. 1 and 3, of pl. xxxix. Phil. Trans. 1880, enlarged views being given of the most advanced ovum (the natural size being 6 millim. in diameter) in figs. 2, 4, and 5 of the same plate. A magnified view of a portion of the outer tunic (" hyalinion ") of the ovum is given in fig. 3. This tunic was thin, smooth, without trace of vascularity, and the sole indication of commencing development was a linear indentation of the vitelline membrane of the single ovum.

Continuing the correspondence with my coadjutor in this quest, I subsequently received the female organs, preserved in alcohol, of an *Echidna*, captured in the month of September, 1882, in the vicinity of Toowoomba. The increased size of both uteri led me to hope for more decided testimony on the moot question of the oviparity or ovo-viviparity of the Monotremes.

The right uterus was laid open and a collapsed ovum was exposed; an accomplished artist was engaged to make the drawing (Pl. XIII. fig. 1) before proceeding further with the quest. This being completed I laid open the left uterus by a similar longitudinal incision, and exposed a still more collapsed ovum (*ib.* fig. 2, g').

In both uteri the absence of any connexion of the ova with the uterine walls was shown by their floating freely as moved by the feeble wave of the menstruum in which the dissection was made. The vitelline mass, exposed by the section of the outer tunic, had assumed a similar elongate figure (h', fig. 2).

The flattened ovum, *f*, of the right uterus was then removed, and the vitelline mass exposed, as in fig. 3. A linear indent of the vitelline membrane, *h*, seemed to repeat that noted in the smaller ovum of the specimen previously (1880) described. The chief change, besides increase of size, was the increased thickness of the smooth tough outer tunic (" chorion " or " hyalinion "), in which as little trace of vascularity was present as in the ovum at the earlier period of its uterine existence. I concluded therefore that the undeveloped ovum would have been excluded as such; and the confirmation of this view is given in an Australian periodical with which I was subsequently favoured.

In the 'South Australian Register' of September 8, 1884, the Director of the South Australian Museum, Adelaide, J. W.

Haacke, Ph.D., records the fact that on the 25th August in that year he found an egg "in the mammary pouch (not the uterus) of a living *Echidna hystrix*, which he had received about the 3rd of the same month from Kangaroo Island. The egg was unfortunately decomposed inside; but the circumstance of the mother having been worried by being captured and kept in captivity easily accounts for this. On Tuesday, September 2nd, Dr. Haacke laid a number of specimens on the table, including an egg found in the pouch of a female *Echidna*, in support of the theory that the Echidna, though a milk-giving animal, lays eggs, which are hatched in the pouch."

Since the foregoing paragraphs were in type, I have been favoured with a letter (dated Sept. 16, 1884) from my friend Dr. Bennett, F.L.S., of Sydney, New South Wales, enclosing the subjoined "cutting" from the 'Sydney Herald' newspaper:—

"*Embryology.*

"*To the Editor of the 'Herald.'*

"Sir,—I send you the following information, believing that the fact will interest some of your readers. The embryology of the Monotremata *Ornithorhynchus* and *Echidna*, commonly known as platypus and porcupine, is, up to the present time, absolutely unknown. Considering the unique structure of these animals, it was probable that a knowledge of their development would yield important results. This is the case in a greater degree than I had anticipated. Both forms are oviparous. The amount of food-yolk in the egg is very large, and consequently there is only a partial *segmentum* (meroblastic type). The egg is laid at an age equal to a 30-hour-old chick, and is enclosed in a strong, flexible, white shell; it measures about three fourths of an inch in the long axis and half an inch in the short.

"*Ornithorhynchus* produces two such eggs at a birth, while *Echidna* has only a single one. The former places her eggs in the nest at the end of one of the burrows, the latter carries her egg in a ventral pouch. I have already obtained most of the stages in the development, and hope to get a sufficient number during the present breeding-season. I take this opportunity of asking your readers to help me to get a larger number of the embryos of marsupial animals than I at present possess. Since my arrival last October I have collected many embryos of several marsupial genera, including native bears and opossums, and some kangaroo and wallabies. I must get many more before I shall have enough to work out all the problems of the development. I shall be deeply indebted to any one who will inform me in time of an approaching kangaroo drive. It matters not to me whether the drive be in New South Wales, Victoria, Queensland, or South Australia, so long as the place be fairly accessible. A drive where the kangaroos are yarded would be preferable. An answer, giving an estimate of the number of animals likely to be obtained, addressed to my headquarters, Board of Health Office, Sydney, will reach me.

"Yours, &c.,
W. H. Caldwell."

"In Camp, Burnett River,
Queensland, 1884."

I can only add an expression of thankfulness for having lived to see solved, and mainly by Mr. Caldwell's persevering researches, a biological problem which I have sought to determine since the date of a paper on the *Ornithorhynchus* in the 'Philosophical Transactions,' 1832, p. 517.

EXPLANATION OF PLATE XIII.

Fig. 1. Anterior or ventral view of the female organs, urinary bladder, and cloaca (nat. size) of *Echidna hystrix*; the right uterus laid open, and exposing a collapsed ovum.

Fig. 2. The same parts, with both uteri laid open.

(In both figures: *a*, ovarium; *b*, abdominal orifice of oviduct, *b'*; *c*, uterus; *d*, urogenital canal or cloaca; *e*, urinary bladder; *f*, uterine ovum; *g*, hyalinion or outer tunic; *h*, vitelline mass.)

Fig. 3. Ovum from the right uterus, with the vitelline or undeveloped embryonal mass exposed.

XLVI.—*On the Coleopterous Genus* Macrotoma. By Charles O. Waterhouse.

Having recently had occasion to examine some specimens of the genus *Macrotoma* and to consult various Catalogues referring to this group of Longicorns, I was surprised in all cases to find *Macrotoma Hayesii*, Hope, placed as a synonym of *M. serripes*, Fabr., the Munich Catalogue giving *M. Hayesii* as the male, and *M. serripes* as the female. I do not know how this very great error originated; but it is difficult to conceive how any one who had compared the figures given by Hope and Olivier could have supposed them to represent the sexes of the same species. The figure given by Olivier from the type in the Banksian collection very fairly represents the insect, which is of peculiar form, and not at all like the elongate *M. Hayesii*. The type is a male. I have never seen any other specimen. The female would doubtless be difficult to distinguish from *M. prionobius*, White. M. Thomson has not noticed the error of confounding these two species, and in his 'Systema Cerambycidarum,' where he correctly gives *M. serripes* as the type of the genus, he adds *M. Hayesii* as a synonym. In his description of *M. natala* (Classif. des Céramb. p. 315) he compares it with "*M. serripes*," but is evidently referring to *M. Hayesii* *.

In the description of *M. valida* ("Typi Ceramb.," Rev. Zool. 1877, p. 271), M. Thomson, unfortunately, does not say whether the femora are spined on the upper as well as the lower edge, although his comparing it with *M. natala* rather implies this; he merely says, "Pedes læves, nitidi, modicè spinosi"—a very loose way of giving important characters in a very difficult genus.

If, as I suppose, *M. valida*, Th., has both edges of the femora spined, it *may* possibly be the female of the true *M. serripes*. This is, however, only a suggestion.

At the end of his description of *M. serricollis* ("Typi Ceramb.," Rev. Zool. 1877, p. 272) M. Thomson has the following observation :—"Assez grande et belle espèce très-distinct, qui, avec *M. absurda*, White, *M. serripes*, Oliv., *M. gregaria* (Dej.), Th., et *M. scutellaris*, Germ., compose le genre *Prionobius*, Muls., d'ailleurs identique avec le genre actuel."

M. serricollis is described as having "*Pedes validi, asperi, omnes subtus spinosi*." *M. serripes* is the type of the genus *Macrotoma*. *M. absurda* is one of those species which have a few spines on the upper as well as the under side of the femora, and also has some very small spines on the tibiæ ; it cannot therefore be a *Prionobius*, which is characterized by its having the tibiæ *not* spined.

This leads me to another error. In the Stettin. ent. Zeit. 1881, p. 313, Dohrn has a note on *M. absurda*, Newm., in which he gives it as his opinion that that species should be placed in the genus *Remphan* (among other reasons) because it has the "anterior angles of the prothorax projecting over the head"—a character quite foreign to *M. absurda*, which has only a small acute tooth at the anterior angle.

Another view of *M. serripes* is to regard it as "*M. dimidi-*

* Lacordaire (Gen. d. Coléopt. viii. p. 97) evidently refers to *M. Hayesii* as *M. serripes*.

aticornis, Dej." This was adopted by Chevrolat, and by the late Adam White, in the British-Museum collection [but not in his catalogue], and as I had not, when I wrote my descriptions of Madagascar *Macrotomæ*, discovered this erroneous determination, it is to this "*serripes*" that I alluded in the description of *M. obscura* (Ann. & Mag. Nat. Hist. v. (1880), p. 410). My description is, however, not materially affected by the reference.

The following species appear to be undescribed:—

Macrotoma signaticollis, sp. n.

♂. Dark brown, the head, base of the antennæ, the thorax, and front femora nearly black. Basal joint of the antennæ twice as long as broad, very rugose; the third joint as long as the fourth, fifth, and half the sixth together, very rough, and closely spinose beneath; the following joints with a few large punctures, the fourth and fifth with a few small spines beneath; the extreme apex of the eighth, the base and apex of the ninth, and the whole of the tenth and eleventh joints longitudinally grooved. Thorax one quarter narrower in front than at the base, densely punctured on the disk, somewhat rugose on the sides; the lateral spines moderately long: on the fore part of the disk there are two elongate, oblique, uneven, slightly more shining impressions: there is a short, obscure, smooth line running from the middle of the disk to the base, which has a narrow more shining border. The elytra are parallel and convex, somewhat rugosely sculptured, especially near the scutellum; the apical sutural angle distinctly dentiform. Anterior femora asperate and rather closely spined beneath. The anterior tibiæ very rough and closely spined. The posterior femora shining, with a few obscure punctures, and with a series of small spines beneath; the tibiæ not very closely asperate-punctate, with a few short fine spines on both edges. Prosternal process arched, unusually broad and flat, *i. e.* the middle is not raised above the level of the margins; opaque, densely and finely punctured. Metasternum opaque, densely and finely punctured; the central part shining and pubescent, finely but obscurely punctured, with an admixture of larger punctures; the dull and shining parts divided by a sharply defined line. Abdomen smooth and shining, with irregular punctuation at the sides, and there is some obscure punctuation at the base of the basal segments.

Hab. —— ? One of the examples bears the label "Africa, T. B. Berington." It is, however, so completely an Indian form that I think there must be a mistake in the label. The species should be placed between *M. luzonum* and *M. Ellioti*, described below. It differs from *M. Ellioti* in having the legs and antennæ much more spinose; the apical joints of the latter differently and more strongly grooved, and relatively shorter, the third joint being about equal to the five apical joints taken together; whereas in *M. Ellioti* the third joint is not much longer than the three apical joints together. The thorax is rather more convex and less dull, owing to the punctuation not being quite so much crowded; the discoidal impressions are smaller, narrower, and less conspicuous, and the smooth border at the base is very narrow and obscure.

Macrotoma Ellioti, sp. n.

♂. Fuscous, with the elytra brown; the apex of the antennæ and the posterior legs, and the tarsi somewhat pitchy. Head coarsely punctured between the eyes, with the usual frontal impression not very deep, impunctate; the back of the head closely and finely granulose. Antennæ reaching to two thirds the length of the elytra; the basal joint about twice as long as broad, closely and very coarsely punctured: the third joint 14 millim. long, as long as the fourth, fifth, and two thirds of the sixth joints taken together, the surface somewhat wrinkled and punctured, the front margin and under surface with short spines; the fourth to eighth joints shining and sparingly punctured above; the ninth more finely and more closely punctured; the apex of the ninth and the apical joints opaque and longitudinally rugose: there is a small opaque spot on the underside of the apex of the third joint; and on the outer side of the apex of the fourth, fifth, sixth, seventh, and eighth joints there is a small, slightly elongate opaque spot; the eighth has also a small spot at the base, and the whole side of the ninth is opaque. Thorax one fifth broader at the base than at the apex, dull, densely and finely punctured, with two triangular shining marks on the disk. Immediately outside each of these marks is a small round rugose spot, which emits a rugose line towards the sides and directed backwards. The middle portion of the base is shining and strongly punctured, with a smooth line emitted from its fore margin to the middle of the disk, and at each side there is a rugose line directed forwards towards the sublateral rugose spot. The marginal spines are short and not very numerous. The elytra are rusty brown, a little paler towards the apex; densely and moderately finely rugulose-punctate and extremely finely granular, the granulation becoming gradually more distinct towards the base, till near the scutellum the surface is rough. Each elytron has the usual four lines. The sutural angle is not spined. The anterior femora and tibiæ are rough and beset beneath with short acute spines. The posterior femora are shining, sparingly and obscurely punctured, with a few short acute spines beneath. The posterior tibiæ are moderately strongly, but not very closely, punctured on the outer side, with a few very small teeth below. Prosternal process densely and moderately finely punctured, strongly margined on each side. Mesosternum rather more finely punctured and deeply impressed on each side. Metasternum pubescent, densely and finely punctured, except a large triangular medial patch, which is shining and very delicately punctured. Abdomen shining in the middle, somewhat opaque at the sides.

Length 28 lines.

Hab. India (*Elliot*).

Macrotoma inscripta, sp. n.

Fuscous, with the elytra brown, dusky at the base. Head coarsely punctured between the eyes, with a longitudinal, smooth, scarcely impressed space in the middle, but with a deep incision between the antennal tubers; the vertex of the head is coarsely but not closely punctured, the sides finely granulose. The thorax is somewhat dull, about one fifth broader at the base than at the apex, densely and finely punctured, with two triangular, shining, strongly punctured impressions on the disk, nearly united to each other and to a smooth line which proceeds from the shining punctured space at the base of the thorax. On each side there is a small rugose spot, and at the end of the smooth basal space there is a short rugose line directed obliquely forwards.

Length 22 lines.

Hab. India; Bombay?

This species is close to the preceding, but is smaller. The vertex of the head is not closely granulose as in that species, and the impression between the eyes is much less marked. The antennæ are very similar, but the basal joint is relatively shorter, about one third longer than broad, and not spined beneath; the third joint is less rough, with fewer and smaller spines below, and is only equal in length to the fourth, fifth, and about one third of the sixth joints taken together. The metasternum has scarcely any pubescence, and the punctured portion is separated from the smooth space by a still more sharply defined line; indeed the line dividing them is slightly raised. The posterior femora have only a few small spines, and those on the tibiæ are very short and are seen with difficulty. One or two very small spines may also be traced on the upper edge of the femora.

Macrotoma plagiata, sp. n.

Nearly black, with the elytra fuscous. Third joint of the antennæ as long as the fourth, fifth, and sixth taken together. Thorax dull, densely and finely punctured, with two shining, sparingly punctured, very slightly raised patches on the disk, with a rather deep impression on the inner side of each. On the side there is a small punctured shining spot, and at the base a transverse shining space (also punctured) having a smooth line proceeding from the centre to the middle of the disk. In one specimen this basal space is united to the lateral spot by a shining line. The teeth at the sides of the thorax are extremely short.

Length 20 lines.

Hab. N. India (*Bowring*).

This species is very close to the preceding, but, besides the difference in colour and the relative length of the third joint of the antennæ, it differs in having the disk of the thorax more convex, and the two dorsal shining spots are more ovate and slightly above the surrounding surface; the front legs and basal joints of the antennæ are less rough, and the spines on the posterior femora and tibiæ are very minute, the latter appearing at first sight smooth.

Macrotoma absurda, Newm.

This species is extremely close to the preceding. All the examples, however, before me have the intermediate and posterior femora more or less furnished with small spines on the upper edge, and the third joint of the antennæ is only equal in length to the fourth, fifth, and a little more than half the sixth taken together. The examples vary in length from 13 (the type) to 24 lines.

The female is rather more elongate than the male. The antennæ reach to about the middle of the elytra, are slender and shining, the apex of the ninth and the whole of the tenth and eleventh joints being opaque. There is an opaque spot on the underside of the apex of the third and following joints, the fifth and sixth have also a spot at the base, and on the seventh, eighth, and ninth the basal and apical spots nearly unite. The thorax is smooth and shining above, with a few punctures at the base, and on the fore part of the disk are two oblique impressions with a slight longitudinal swelling between the impression and the lateral coarse punctuation; a little removed from this swelling there is a second, small, round, smooth, elevated spot; there is a well-marked but small impression in the middle of the base. The metasternum is clothed with yellow pubescence, finely and delicately punctured, but the punctuation is more indistinct in the middle area. Legs shining and sparingly punctured. The femora furnished with a few slender spines both above and below. The tibiæ have a few spines on the inner side.

Length 24 lines.

"*Prionus crenatus*, Fabr."

There is in the Museum collection a single male example from M. Chevrolat's collection which bears the Dejeanian label "*Macrotoma lugubris*, mihi, h. in India orient. D. Latreille," and Chevrolat's label, "*Pri. crenatus*, F. S. El. 2. 264." It differs from *M. absurda* only in having the thorax and elytra more convex, with the dorsal marks less impressed. It is perhaps not distinct from *M. absurda*. I see no reference to *P. crenatus*, Fabr., in Gemminger's Catalogue. The Fabrician description would apply to this insect fairly well; but I think it doubtful whether "magnus" would have been applied in this group to a species only 22 lines long.

NOTE.—*M. signaticollis*, *Ellioti*, *inscripta*, *plagiata*, *absurda*, and *M. æneipennis** compose a small group allied to *M. luzonum*, F., characterized by the males having a closely punctured opaque metasternum, with a triangular shining area in the middle.

Macrotoma Fisheri, sp. n.

♂. Ferruginous; the head, three basal joints of the antennæ, and the anterior femora nearly black; the intermediate and posterior legs and all the tarsi pitchy. The whole of the metasternum and the parapleuræ clothed with fulvous-yellow pubescence.

Head opaque, moderately strongly and closely ocellate-punctate on the forehead, densely and finely granulose posteriorly; the deep excavation between the antennal tubers with only a few punctures. Antennæ reaching to two thirds the length of the elytra; the basal joint strongly but not very closely punctured; the third joint 12 millim. long, flattened above, not very closely or strongly punctured, the underside moderately asperate. The fourth to seventh joints smooth above, the seventh more closely punctured than the preceding joints; the eighth to eleventh joints opaque; there is an opaque spot on the underside of the apex of the third joint; the fourth joint is opaque at the side for nearly the whole length, and the fifth, sixth, and seventh joints are opaque at the side for their whole length, the opaque portion having a

* Waterhouse, Trans. Ent. Soc. 1881, p. 428.

fine longitudinal smooth line in the middle. Thorax coarsely rugose, one third narrower in front than at the posterior angles, the sides nearly rectilinear; the disk flattened (or even slightly concave), with a small smooth spot in the middle; the marginal spines are very acute (about fifteen in number) and moderately strong. Scutellum opaque, sparingly punctured. Elytra scarcely wider than the base of the thorax, parallel, pale yellowish brown, with rather darker shade on the shoulders and scutellar region [very much as in *M. luzonum*]; very finely rugulose; the scutellar region beset with minute dark tubercles; the sutural angle not spined. Anterior femora very rough; the tibiæ not very closely asperate-punctate above; beset with strong acute tubercles below. The intermediate femora smooth and shining, beset with not very numerous minute tubercles; the posterior femora with still fewer tubercles; the lower edges of the femora have some very small acute spines; the tibiæ are sparingly punctured, and have a series of very small spines on the lower edge. The prosternal process is coarsely punctured. The mesosternum is opaque, pubescent, deeply impressed on each side. The whole of the metasternum finely punctured and pubescent, the middle portion not quite so closely. Abdomen not very shiny, finely and not very closely punctured.

Length 32 lines.

Hab. Burmah (*Bowring*).

Macrotoma ægrota, Newm.

I have not yet seen the male of this species. A specimen in the Museum collection measures 28 lines in length, the type being only 19 lines.

Macrotoma serricollis, Dejean.

♀. Dark fuscous, the elytra rusty yellow, with the base and longitudinal ridges ferruginous. Head rugose. Antennæ reaching to about the middle of the elytra, slightly dull; the first and third joints moderately strongly but not very closely punctured. The third joint as long as the fourth, fifth, and half the sixth joints taken together. The fourth, fifth, and sixth joints with the lower half on the outer side smooth, with only a very few punctures; the upperside of these joints, as well as nearly the whole of the seventh, closely and finely punctured; the eighth to eleventh opaque and somewhat rough, but not longitudinally channelled. The thorax is nearly twice as broad at the base as at the anterior angles, all the surface rugose, the base deeply sinuate behind each of the posterior angles, which consequently are very prominent and directed backwards and outwards. The fore part is impressed above. The margins have about nine acute teeth. The elytra are at the base a little broader than the thorax, but are distinctly broader a little behind the middle, and then again somewhat narrower, convex at the base, flattened posteriorly, leaving the sutural region (between the suture and the first costa) somewhat raised above the rest of the surface till near the apex; there is a second costa not much removed from the first, and the space between them is concave. There is a well-marked sublateral obtuse costa, which extends nearly to the apex; the side of the elytra outside this costa is nearly perpendicular, the margin itself being reflexed. The usual third costa is absent, the space between the second costa and the lateral one being gently concave. All the basal region is rugose, and the rough sculpture is continued for some distance down the sutural region and on the lateral costa. The prosternal process is very coarsely rugose. The metasternum is closely and finely punctured and pubescent. The abdomen is somewhat dull, closely and very finely punctured, with the apical margin of the segments smooth and shining. The femora are sparingly asperate-punctate, with a few very small spines beneath; the tibiæ are rough, with a few very small spines on the inner edge.

Length 24 lines.

Hab. Java (*coll. Dejean*).

M. Thomson has in his "Typi" (Rev. Zool. 1877, p. 273) described a species under the name of *M. serricollis*, Dej., to which I have alluded above. I think, however, that his insect cannot be the male of the species I have just described, and I therefore propose to call the female Dejeanian example *M. Dejeanii*.

It is closely allied to *M. Wrightii* (Waterh. Ann. & Mag. Nat. Hist. v. 1880, p. 414), from the Seychelle Islands; and if it were not for the colour of the elytra and the locality, I should have considered them as sexes of the same species.

Macrotoma Cowani, sp. n.

♂. Black, with the elytra and abdomen dark brown. Head very coarsely rugose. Antennæ long, reaching beyond the apex of the elytra; the first joint a trifle more than twice as long as broad, rugose; the third joint moderately asperate, with some very small acute tubercles below, as long as the fourth, fifth, and one quarter of the sixth joints taken together; the fourth to eighth joints are very finely punctured, the punctuation obscure on the fourth and fifth joints, more distinct and very close on the sixth, seventh, and eighth; these joints have also a few large punctures. There is a very small opaque spot at the apical outer angle of the fifth and sixth joints; on the seventh there is a more elongate spot and a similar one at the base; on the eighth joint these spots nearly meet in the middle of the joint; the ninth joint is entirely opaque at the side and partially so at the base and apex above; the tenth and eleventh opaque and longitudinally finely rugulose. Thorax very rugose, one quarter narrower at the anterior angles than at the base; somewhat abruptly enlarged before the posterior angles, which are produced into a short strong spine. The disk is longitudinally impressed in the middle, and on each side of the impression the rugose punctuation is less dense, so that the surface is shining; at the base there is a smooth shining patch. Elytra opaque, closely and very finely granular, the granules at the base very distinct and shining. Metasternum closely and finely punctured and pubescent. Anterior femora very rugose and with short strong spines below. Anterior tibiæ opaque and rough, with numerous short strong spines on both edges. Posterior femora opaque and finely rugose, with numerous strong spines on the upper and lower edges; the tibiæ less opaque, with strong spines on the upper edge, and some very small ones on the lower.

Length 25 lines.

Hab. Madagascar, Fianarantsoa (*Cowan*).

This species differs from *M. obscura* in having much longer antennæ and in having the thorax somewhat constricted in front, with a smooth patch at the base, and without any distinct lateral spines.

Macrotoma Watersii, sp. n.

♂. Very similar to *M. Cowani*, but almost entirely black (the elytra having only a slight pitchy tint). It differs chiefly in the thorax and antennæ. Head very rugose, with a well-marked longitudinal frontal impression. Antennæ extending to the apex of the elytra; basal joint twice as long as broad, slightly rough and strongly punctured; third joint as long as the fourth, fifth, and one third of the sixth joints taken together, finely rugose, with deep punctures scattered over the surface; the underside flat (but not concave), beset with not very numerous very small acute tubercles; the fourth, fifth, and sixth joints obscurely and finely punctured, with some large punctures interspersed; the seventh joint is similar, but slightly dull; the eighth is a little more strongly sculptured; the ninth is longitudinally rugulose (except a spot in the centre), and the tenth and eleventh joints are entirely rugulose. There is no distinct opaque lateral spot till the sixth joint, where there is a long and narrow one; on the seventh the apical spot is longer, and there is also one at the base; on the eighth the basal and apical spots nearly meet; and the whole of the side of the ninth joint is opaque. The anterior femora are very rugose, with short strong spines above and below; the tibiæ are finely rugulose, with short spines on both edges. The intermediate femora are smooth and shining at the base, with a few large punctures; the apical half is more opaque and finely rugulose; the spines on the upper and lower edges are strong and acute. The tibiæ are very finely rugulose; the spines on the upper edge are strong, those on the underside are very small. [The posterior legs are wanting.]

Length 29 lines.

Hab. Madagascar, Betsileo country. Collected by Mr. Thomas Waters.

Macrotoma dimidiaticornis, Dej.

♂. Black above, pitchy beneath; parallel, convex. Head deeply and irregularly punctured between the eyes; the vertex and sides closely and rather finely granulose. Antennæ reaching to a little beyond the middle of the elytra, the fourth and following joints pitchy red; the basal joint strongly punctured, but the punctures are not crowded together; the third joint as long as the fourth, fifth, and half the sixth joints taken together, shining, with a few deep punctures; the fourth to eighth joints shining and sparingly punctured above, the fifth to eighth with a few longitudinal punctures at the base and apex; the ninth is less shining, and at the base and apex slight longitudinal lines may be traced; the tenth and eleventh are dull, but scarcely rugose; taken together they are as long as the third joint. Thorax about one third narrower in front than at the base, very closely and rugosely punctured, somewhat dull, and more or less pubescent, the disk with three irregular impressions, the margins irregularly dentate. Elytra parallel, densely and coarsely rugose, the usual longitudinal lines obsolete. Anterior femora with not very numerous asperate punctures, and with a few very short teeth below; the tibiæ sparingly punctured, with a few tubercles beneath. The posterior legs similar, but a little smoother. Metasternum finely and closely punctured, and clothed with yellowish pubescence. The apex of the abdomen with fulvous hair.

Length 21–25 lines.

Hab. South Africa (*Dr. Smith*).

I have already alluded to this species as one of those in collections under the name *M. serripes*, Oliv., but which I fail to find described. It must not be confounded with *M. scabridorsis*, White (Cat. Long. Brit. Mus. 1853, p. 38). *M. scabridorsis* differs from the one above described in being less opaque, more black below, and the pubescence on the thorax, sternum, and apex of the abdomen is black or nearly so. The basal joint of the antennæ is more closely punctured, and the third joint is channelled above. The fifth joint has a dull longitudinal impression at the side, extending from the apex nearly to the base; and on the following joints this impression gradually increases in extent. The female has the three apical joints very short, broad, and longitudinally rugose.

I should imagine from M. Thomson's imperfect description of *M. atropisoptera* ("Typi," Rev. Z. 1877, p. 272) that his insect is very close to, probably identical with, *M. scabridorsis*. Curiously enough he says that his species is known in some collections under the name *M. pubicollis*, Bohem. MSS., "qu'elle ne mérite d'aucune façon." All the Museum examples of *M. scabridorsis* have the thorax more or less pubescent, but the pubescence being *black*, it is only visible in certain positions.

M. Thomson gives the length 32 to 37 millim. The specimens of *M. scabridorsis* vary from 31 to 42 millim.

British Museum, South Kensington,
November 1884.

XLVII.—*Notes on Batrachians.* By G. A. Boulenger.

Rana corrugata, Ptrs.

I am now convinced that the locality of the specimen said to be from Ningpo in the British Museum is erroneous. That specimen was purchased from Cuming, and in going through the lizard collection I have found strictly Ceylonese species also labelled "Ningpo," and obtained from the same dealer. *Rana corrugata* must therefore be regarded as restricted to Ceylon.

Rana erythræa, Schleg.

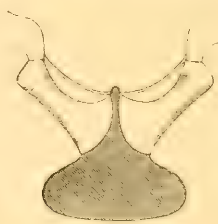
At the time of the publication of the 'Catalogue,' although a great number of specimens had passed through my hands, the male was unknown to me. Having received several male specimens from the island of Nias, I am now able to add to my diagnosis that humeral glands are absent and the vocal sacs internal.

Rhombophryne, Böttg.

Rhombophryne, Böttg. Zool. Anz. 1880, p. 567, and Abh. Senck. Ges. xii. 1882, p. 494.

This remarkable genus was established on the external characters only. The following generic diagnosis, drawn from the osteological characters also, will supplement Böttger's excellent description.

Pupil horizontal. Tongue large, elongate, entire, free at the sides only, longitudinally grooved. A non-interrupted angular series of palatine teeth. A cutaneous fold across the palate between the choanæ. Tympanum hidden. Fingers and toes free, the latter with the tips slightly dilated. Outer metatarsals united. Inner metatarsal tubercle very large.



Coracoids strongly dilated, directed a little backwards; precoracoids extremely feeble; no omosternum; sternum large, cartilaginous. Sacral vertebra with feebly dilated diapophyses, articulated to coccyx by two condyles. Terminal phalanges simple.

In its skeleton *Rhombophryne* approaches much nearer *Scaphiophryne* than *Breviceps*, near which it was provisionally placed.

I take this opportunity to correct a serious error of Parker*, which has recently been repeated by Sabatier †. The former author has described and figured the sternal apparatus of two "species" of *Breviceps*, viz. *Systoma gibbosum*, Wagl., and *S. granosum*, Dum. (these names are synonyms), which are said to differ from each other in having the elements of the pectoral arch precisely reversed as to shape and relative size.

* 'Monograph of the Shoulder-Girdle' (Ray Soc. 1868).

† 'Comparaison des ceintures et des membres antérieur et postérieur dans la série des vertébrés' (1880).

I now find that the account of *S. gibbosum* with the reversed shoulder-girdle was taken from a mounted skeleton in Hyrtl's collection, which was purchased by the museum of the College of Surgeons. This specimen was prepared with the pectoral arch upside down.

Leptodactylus gracilis, D. & B.

Several specimens were sent by Dr. v. Ihering from the province Rio Grande do Sul which agree perfectly with Bibron's description. Hensel was therefore right in referring his specimens to *L. gracilis*, and I was wrong in including his note in the synonymy of *L. typhonius.*

Tongue oval, indistinctly nicked behind. Vomerine teeth in two slightly arched series behind the choanæ, separated by a very narrow interspace. Snout acuminate, longer than the diameter of the orbit; nostril nearer the tip of the snout than the eye; interorbital space nearly as broad as the upper eyelid; tympanum two thirds the width of the eye. First finger much longer than second; toes slender, not fringed; subarticular tubercles well developed; inner metatarsal tubercle very small; outer metatarsal tubercle very indistinct or absent. The hind limb being carried forwards along the body, the tibio-tarsal articulation reaches beyond the tip of the snout. Skin smooth, with longitudinal folds along the back, the outer one on each side being the most developed; a ventral discoidal fold. Brown or olive-brown above, with black spots more or less confluent into longitudinal bands on the body; a pale brown vertebral band; a black streak from the tip of the snout, through the eye, to the tympanum, and another bordering the upper lip; limbs with irregular cross bars; hinder side of thighs with large black marblings, more or less confluent into longitudinal bands; beneath white, immaculate. Male with an internal vocal sac; thumb without spinose tubercles.

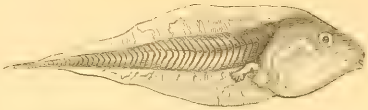
Bufo arenarum, Hens.

On comparison of a small specimen from Catamarca, presented to the Natural History Museum by Lord Dormer, with the description of *B. mendocinus*, Philippi, Arch. f. Naturg. 1869, p. 44, I am convinced that the latter is to be referred to the synonymy of *B. arenarum.*

Hyla rubra, Daud.

Several larvæ, including stages sufficiently advanced to permit of naming the species, were collected at Recife, Pernambuco, by the late W. A. Forbes.

Except in the position of the anus they differ but little from the ordinary *Hyla*-larvæ. I have observed three different positions of the anal opening in the tadpoles of tailless Batrachians. The first, which may be called *median*, occurs in



Pseudis, *Pelobates*, *Alytes*, *Xenopus*, &c. The anal tube is median, and opens on the middle line of the lower edge of the tail. The second, or *sublateral*, occurs in *Rana*; the anal tube is obliquely directed from left to right, and opens on the right side of the lower edge of the caudal membrane. The third, or *lateral*, I observe in the present species; the anal tube is extremely reduced and opens high up on the right side of the tail, just below the muscular portion of the latter. When the limbs have reached their full development, and the alimentary canal undergoes its transformation, and the definitive anal opening makes its appearance, the caudal membrane becomes perforated behind the thighs; then, in the forms with *lateral* anus both tube and opening disappear, whilst in the others they persist, functionless, till the absorption of the caudal membrane.

The mouth is that of a typical *Hyla*. The lateral borders of the lips are continuous at the point of union of the upper with the lower, and bordered with papillæ except on the middle of the upper lip, which is slightly incised; numerous papillæ on each side of the mouth within the lips. Two parallel rows of ciliate teeth on the upper lip, the marginal uninterrupted, the inner as long but interrupted medially; three equally long rows of teeth on the lower lip, the inner slightly interrupted in the middle, the two outer continuous.

The body is short and globular; its length is contained twice and one third to twice and a half in the length of the tail. The latter is furnished with much-developed upper and lower crest, which taper to a fine point; the greatest height of the tail nearly equals the length of the body; the upper membrane extends upon the body as far as the posterior margin of the eye.

The colour appears to have been silvery with small grey spots; the tail is veined or more or less marbled or spotted with grey; in one specimen, which belongs doubtless to the same species, there is a large, round, deep-black spot on the side of the tail, nearly halfway between the tip of the latter and the body.

	millim.
Total length	45
Body	14
From end of snout to eye	5
Tail	32
Height of tail	14

XLVIII.—*Notes on the Palæozoic Bivalved Entomostraca.*— No. XVIII. *Some Species of the* Entomididæ. By Prof. T. Rupert Jones, F.R.S., F.G.S.

[Plate XV. *]

The genus *Entomis*, first determined in 1861, was described in detail in the Ann. & Mag. Nat. Hist. ser. 4, 1873, vol. xi. p. 413. *E. tuberosa*, Jones, mentioned *op. cit.* pp. 413 and 415, is not very uncommon in some Upper-Silurian strata and deserves further notice. Its carapace-valves themselves have been very rarely preserved † ; but the casts afford some material for further illustration.

1. *Entomis tuberosa*, Jones. (Pl. XV. fig. 1.)

Entomis tuberosa, Jones, Mem. Geol. Surv. Scotl., Explan. Map 32, 1861, p. 137, pl. ii. fig. 5; Ann. & Mag. Nat. Hist. ser. 4, 1873, vol. xi. p. 413.

Entomis pelagica, Barrande, Syst. Sil. Bohême, vol. i. Suppl. 1872, p. 515, pl. xxxiv. figs. 1–6; De Koninck, Mém. Soc. roy. Sci. Liége, sér. 2, vol. vi. 1876, p. 45.

Entomis tuberosa, Woodward, Cat. Brit. Foss. Crust. 1877, p. 120.

Entomis pelagica et *E. tuberosa*, R. Eth., Jun., Cat. Austral. Fossils, 1878, p. 16.

Valves suboval, in a specimen (fig. 1) from the Pentland Hills, Scotland ‡, $\frac{3}{16}$ inch long and $\frac{2}{16}$ wide, and one from Bow Bridge, Ludlow §, $\frac{1}{4}$ inch long and $\frac{1}{6}$ wide. Although the pressure which has affected the mudstone matrix of these casts has more or less altered the shape of the valves,

* The drawing of this lithographic plate has been made under a grant from the Royal Society.

† Henry Johnson, Esq., F.G.S., of Dudley, has kindly lent me a well-preserved specimen, with the test, while this paper is going through the press.

‡ Cat. Cambr. Silur. Foss. Mus. Pract. Geol. 1878, p. 130 ($\frac{2}{2}\frac{5}{5}$), in a yellowish sandstone, with two small spiral Gasteropods.

§ *Loc. cit.* ($\frac{2}{2}\frac{6}{6}$), in grey calcareous shale.

yet the following features are distinguishable:—The dorsal margin is nearly straight in its middle third, and curves off rapidly at the ends. The ventral margin is rounded, but most convex in the posterior third. The extremities are rounded; the anterior end narrower than the other. The dorsal sulcus is strongly marked, curved forwards, and indenting nearly three fourths of the width of the valve. Anterior to the furrow, and within its curve, the surface of the valve is raised up into a low cone or tubercle. In the specimen from Bow Bridge the valves are much flattened by pressure.

Another specimen * of the same species comes from Whitcliff, Ludlow, near the place of that last mentioned, and in the same kind of shaly mudstone of the Upper-Ludlow series. It is also preserved in the Museum of Practical Geology, Jermyn Street.

Specimens closely resembling the foregoing were collected about or before 1866 by Messrs. Haswell, Brown, and Henderson, of Edinburgh, in the Upper-Silurian mudstone of the Pentland Hills.

A very fine and well-preserved, though slightly crushed, specimen of *E. tuberosa* † has been obtained from the Upper Wenlock shale of Dudley by Henry Johnson, Esq., F.G.S. &c., of that place. The material of its valves is preserved, brown and smooth, somewhat crumpled by pressure. The two valves lie side by side in a bluish-grey limestone; the dorsal edge of the left valve has been slightly pushed over that of the other valve. They retain some of their original convexity; but the tubercle in front of the curved sulcus is depressed and pushed backward. Length of valve $\frac{5}{10}$, height $\frac{3}{10}$ inch.

The Australian specimens of *Entomis tuberosa* referred to in the Mem. Geol. Surv. Scotland (32), 1861, p. 137, and Ann. & Mag. Nat. Hist. June 1873, p. 415, were collected by the late Count P. E. de Strzelecki ‡ at Yarralumla, Queen-

* *Loc. cit.* ($\frac{26}{27}$).

† This fine specimen, together with some rare, well-preserved, and large Entomids from the Lower-Ludlow Shale of Sedgley, has been kindly lent to me by Mr. Henry Johnson, of Dudley; and I have been able to get one of the latter figured in time for this communication. He has also been so good as to communicate others, collected by Mr. C. Beale from the same shale.

‡ They are not mentioned in the Count's book 'Physical Description of New South Wales and Van Diemen's Land,' 8vo, London, 1845. The Rev. W. B. Clarke refers to these mudstones of Yarralumla, with *Encrinurus* and *Calymene*, in his "Remarks on the Sedimentary Formations of New South Wales," in the Appendix to the 'Catalogue of Natural and Industrial Products of New South Wales,' &c., 1867, p. 69.

begun, New South Wales, and are now in the British Museum (Natural History).

These are internal casts, in a brownish fine-grained sandy mudstone, and are associated with numerous ferruginous casts and impressions of Trilobites (broken) and Brachiopods, such as *Cybele*, *Proetus*, and *Cyphaspis*; *Orthis*, *Strophomena*, &c. Besides several individuals of the *Entomis*, variously modified by pressure (figs. 5, 6, and 7), there is a cast (internal) of another Entomostracan form (fig. 17), the outline of which is much like that of a *Halocypris* or a *Conchœcia*. Provisionally, however, I refer it to the Cypridinidæ.

Prof. Dr. L. de Koninck *, of Liége, has recognized in some olive-coloured argillaceous rock from the same locality (Yarralumla) specimens of apparently the same *Entomis* as that above mentioned, together with numerous fragments of Trilobites (*Calymene*, *Cheirurus*, *Cromus*, *Encrinurus*, *Proetus*), and a branch of *Alveolites repens*.

M. de Koninck refers the species to M. Barrande's *Entomis pelagica*, Syst. Sil. Bohême, vol. i. Suppl. 1872, p. 515, pl. xxiv. figs. 1–6, which show the unaltered valves, with their shape and profile well preserved, from the Upper-Silurian stage, F f 2, at Konieprus, Bohemia. The size of these is, for the largest specimens, about 6 millim. long and about 3 millim. in width. The test is smooth and very thin. M. de Koninck adopts M. Barrande's description of the valves in great part, but does not mention whether his specimens were in the state of casts or not.

It is extremely probable, if not certain, that *E. pelagica* and *E. tuberosa* are synonymous; and I would readily adopt M. Barrande's appellation if the priority of the other did not hinder me. The great extension of this old creature's habitat, where now Scotland, Shropshire, Staffordshire, Bohemia, and New South Wales severally exist, is very remarkable, and indicates its truly pelagic nature.

* "Recherches sur les fossiles paléozoiques de la Nouvelle-Galles du Sud (Australie)." Extrait des 'Mémoires de la Société royale des Sciences de Liége,' 2e série, vol. vi. 1876, p. 45.

At page 347 of the same work M. L. de Koninck notices a small Carboniferous Entomostracan, which he terms *Entomis Jonesi*; but from the drawings, figs. 6, 6 *a*, 6 *b*, pl. xxiv., this seems to me to be more like M'Coy's *Beyrichia* (?) *bituberculata*, having two equal lobes distinctly divided by a broad transverse valley. A few individuals were found associated with a little crowd of *Polycope simplex*, J. & K., in the sandstone of Muree, N. S. W.

2. *Entomis depressa*, Salter MS.
(Pl. XV. figs. 2, 3.)

Entomis depressa, Salter MS., Cat. Cambr. Silur. Foss. Mus. Pract. Geol. 1878, p. 125.

Valves nearly oval, resembling those of *E. tuberosa*, but destitute of the large tubercle or swelling on the anterior moiety, within the curvature of the sulcus. A very small tubercle, however, is visible on the internal cast of each valve at or near the umbilical termination of the sulcus.

Size of valve $\frac{10}{50} \times \frac{6}{50}$ inch; and $\frac{15}{50} \times \frac{8}{50}$ inch.

This form occurs in the Aymestry Limestone at Mocktree, Shropshire *; also in Upper-Ludlow mudstone at Aymestry Common †.

3. *Entomis Marstoniana*, sp. nov. (Pl. XV. fig. 8.)

In the Museum of Practical Geology ($\frac{23}{31a}$) is an interesting specimen of two pairs of opened valves, each nearly semicircular in shape, only slightly convex (on account of pressure), and with a short, neatly curved, dorsal furrow. The valves are quite smooth, retaining a delicate film of the decomposed test, and showing no spot or tubercle, only a slightly raised marginal rim where the edge of the valve is here and there perfect. This fossil is in the bluish-grey calcareous shale of the Lower-Ludlow series, from Mocktree, and was presented to the museum by Mr. A. Marston, of Ludlow; and I gladly associate his name with this species, for he is well known to have worked hard among the fossils of the Silurian and Cambrian rocks of Shropshire, and to have added much to our knowledge of the palæontology of these old rocks.

Size of valve $\frac{15}{50} \times \frac{12}{50}$ inch.

Another specimen with this circular form, but not well preserved, in the Museum of Practical Geology ‡, is from the Upper-Silurian olive-brown mudstone at Ludlow.

4. *Entomis Haswelliana*, sp. nov. (Pl. XV. figs. 9, 10.)

Some internal casts of small valves referable to *Entomis*, collected by the late Mr. G. C. Haswell about 1866 in the Upper-Silurian mudstone of the Pentland Hills (probably near the North-Esk reservoir), indicate a species with broadly ovate valves, which are uniformly convex, though impressed with a strong dorsal sulcus. This is narrow, rather sinuous,

* Cat. Pal. Foss. Mus. Pract. Geol. 1878, p. 125 ($\frac{25}{4}$).
† *Op. cit.* p. 131 (D $\frac{24}{12}$).
‡ Cat. Pal. Foss. 1878, p. 130 ($\frac{26}{28}$).

and ends in an umbilical depression, sometimes with a small central tubercle; and numerous fine lines radiate downwards and outwards over this lower part of the sulcus. This interesting feature*, belonging to the "muscle-spot," brings *Entomis* into close relation with other bivalved Entomostraca, in which the "vascular spot" or radiating group of vessels is present at or near the centre of each valve, where the transverse muscle is attached. Size of valves $\frac{15}{50} \times \frac{10}{50}$ inch.

5. *Entomis Angelini*, sp. nov. (Pl. XV. fig. 14.)

This form has been figured by the late Prof. Angelin, of Stockholm, in an unpublished quarto lithographed plate of Upper-Silurian bivalved Entomostraca, presumedly Swedish, and probably from Gothland. This plate was referred to by Dr. Fr. Schmidt in 1873. Our fig. 14 is copied from "fig. 10" of this "Tab. A," which was kindly given to me by Dr. Lindström in 1861, but could not be used at that time. The specimen seems to have been figured of the natural size ($\frac{15}{25} \times \frac{10}{25}$ inch), and shows a strongly convex bivalved carapace, impressed across the dorsal region with a curved furrow, dividing the surface into two parts of unequal convexity. In these features it somewhat resembles Kolmodin's *Elpe reniformis* (Œfversigt Kongl. Vetensk.-Akad. Förhandl. 1879, vol. xxxvi., 1880, p. 135, pl. xix. figs. 2 *a*–2 *c*); but the latter is almost equally convex on both moieties of the valves.

M. Barrande's *Elpe pinguis* † (Syst. Sil. Bohême, vol. i. Suppl. 1872, p. 512, pl. xxvi. figs. 15 *a*–15 *c*) may belong to the same genus; but *Elpe inchoata*, Barr. (*ibid.* p. 511, pl. xxvi. figs. 10 *a*–10 *e*), appears to me to be more nearly related to *Entomoconchus*, as Barrande at first thought; indeed he seems to have been very uncertain as to the zoological placing of these two species. To enable us to catalogue and refer to Angelin's figured *Entomis*, I venture to suggest a specific name for it; and unless our friends in Sweden have already given a name, I propose to dedicate it to Angelin himself, so well known and eminent among palæontologists.

The relatively large size of the specimens here referred to under the above heading might seem at first sight to separate them from the other fossils described in this paper; but, in

* The radiate muscle-spot is referred to at p. 413 Ann. & Mag. Nat. Hist. June 1873, as occurring in *Entomis tuberosa*; this should be, as we now see, *E. Haswelliana*.

† The *Cythere cincinnatiensis*, Meek, Geol. Surv. Ohio, vol. i. part 2, 1873, p. 158, pl. xiv. figs. 1 *a*–1 *d*, closely approximates to *Elpe pinguis*, Barrande, though less globose. It is from the Lower Silurian o Cincinnati, Ohio.

other respects, Angelin's figure, Kolmodin's *Elpe reniformis*, and Barrande's *Elpe pinguis* are certainly related to the genus (*Entomis*) under notice, and the largest *Entomis tuberosa* and some large Entomids now to be described remove any difficulty in associating them together.

6. *Entomis reniformis* (Kolmodin). (Pl. XV. fig. 22.)

Elpe reniformis, Kolmodin, "Ostracoda Silurica Gotlandiæ," Œfv. K. Vet.-Åk. Förh. vol. xxxvi. 1880, p. 135, pl. xix. fig. 2 *a–c*.

Some remarks have been already made, in the notice of fig. 14, on Kolmodin's species here mentioned. Since that was written, Henry Johnson, Esq., of Dudley, has kindly lent me some well-preserved but somewhat depressed specimens of what appears to be this species, from the Lower-Ludlow Shale of Sedgley, not far from Dudley. The test is brownish and smooth. The valves are nearly semicircular, $\frac{4}{10}$ inch long and $\frac{3}{10}$ high; their original nearly uniform convexity has been interfered with by pressure, and the surfaces are in consequence irregularly undulate. The slightly curved dorsal sulcus is quite distinct, and an obscure tuberculation or other irregularity of surface is traceable at its umbilical end. This reminds us of what we see of the umbilical features in *Entomis Haswelliana* (p. 394) as internal casts, which may have had equally smooth valves, with but slight indications of the internal markings. The dorsal furrow reaches to the middle of the valve, and the two moieties of the surface are of equal convexity. I regard as the *anterior* the part within the curve of the furrow; Dr. Kolmodin has referred to that part as the "posterior."

7. *Entomis globulosa*, Jones. (Pl. XV. figs. 11 *a–e*, 12.)

I. In the 'Monograph of the Silurian Fossils of the Girvan District in Ayrshire,' by H. A. Nicholson and R. Etheridge, Jun. (vol. i. 2nd fasciculus, 1880, p. 223), a little subconical fossil was described and figured (pl. xv. fig. 12, *a*, *b*) as a peculiar form of *Entomis*, originally very globose, but subsequently squeezed in such a manner that the dorsal sulcus was made to lie in the greater axis of the fossil instead of across the long axis of the original valve. Thus—"the subconical or nearly hemispherical fossil, with a somewhat oval base-line ($\frac{1}{8}$ by $\frac{1}{12}$ inch), here figured, is an internal cast (in mudstone) of a tent-like shell, carapace, or valve, of doubtful relationship. I believe it to be an Entomostracan valve. It is referred to in the Mem. Geol. Surv. Scotland (Explan. Sheet 3, Western

Wigtonshire, 1873, p. 34) as having been found (about 1872) in the soft grey micaceous mudstone (weathering rusty) of the hillside opposite Blair Farm, about 8½ miles north-east of Girvan, and as having an analogue in some better-preserved specimens from the Pentland Hills. In the Girvan specimen, which is in the collection of the Geological Survey of Scotland, and marked 'M. 1920,' an apical depression, not quite central, is continued a little way on the longer axis of the cast by a tapering furrow. Studied in the light given by some other Entomids, this appears to me to be the cast of a valve of a very globose *Entomis*, and that it has been squeezed from end to end, so that the long and short axes have been mutually interchanged. The better specimens are considered as typical of a new species, *Entomis globulosa*." This is again figured here as fig. 12.

It belongs to the Upper-Silurian stage both in Ayrshire and the Pentland Hills.

II. The late Mr. G. C. Haswell, of Edinburgh, submitted for examination, in 1866, two somewhat similar but larger specimens, from the Upper-Silurian mudstones of the Pentland Hills.

1. Fig. 13. One of these specimens had a suboval base, somewhat more boldly curved on one side than on the other, and a conical elevation with unequal slopes, the apex being nearer one end of the longer axis than the other. Size: length $\frac{5}{16}$, breadth $\frac{3}{16}$, height $\frac{2}{16}$ inch. There is no apical depression; the edge all round was evidently compressed so as to present a vertical rim (narrower and more inturned apparently where partially buried in the matrix on the flatter side), representing the cast of the inside of a flange, set on nearly at right angles within the margin, to receive the opposite edge of a corresponding valve, as on the ventral margin of *Leperditia* (see Ann. & Mag. Nat. Hist. ser. 2, vol. xvii. pl. vi. fig. 4 *c*). The *conical* condition may be the result of pressure, which has obliterated the umbilical spot.

2. The second analogous specimen (figs. 11 *a*–11 *c*) from the Pentland Hills was a somewhat similar cast, nearly hemispherical, with a slightly oval base-line, and vertically rimmed all round, but not so deeply and uniformly as in the specimen last described; nor was the margin quite even on one plane; for the middle of one moiety had a slight extension. A marked line (transverse to the longer axis of the fossil) passes from this median projection, over the cast, to the central or umbilical depression, and is continued, as a definite furrow, to the opposite margin, where it widens, making the vertical rim locally more distinct. The apical depression has a smooth,

circular, ridge-like border, interrupted on two sides by the line and the sulcus, the ends of which in the depression are separated one from the other by a central tubercle. Moreover there are numerous very delicate, wavy, radiating, vascular impressions, starting from the pit, crossing its bounding ridge, and meandering over the outside of the cast. Size: length $\frac{3}{12}$, breadth $\frac{3}{16}$, height $\frac{1}{12}$ inch.

III. *Comparison of the three Specimens* (I., II. 1, II. 2).— They agree in their more or less hemispherical shape, although pressure may have modified each. It is quite possible that the specimen "I." (fig. 12) has suffered lateral pressure so much as to change the longer to the shorter axis; for the analogous furrow in *Entomis* &c. is transverse to, and not parallel with, the long axis, unless under pressure acting on the ends. In this specimen there are neither vascular markings nor marginal rim preserved, which features indicate alliance to *Leperditia*, *Entomis*, &c.

Specimen "II. 1" (fig. 13) shows signs of having been slightly crushed; its shape therefore is not strictly typical, and the umbilicus may have been obliterated in the conical apex. The smooth marginal rim, which is seen also in *Leperditia*, though not so continuous as here, indicates that this was one of two valves, as in *Leperditia* &c.; but the extreme convexity of each valve (if equal, or nearly so) would make an unusually globular bivalve Entomostracan. *Entomoconchus globulosus* has nearly similar proportions; but it is more uniformly convex and has other distinctive peculiarities.

Specimen "II. 2" (fig. 11) seems to me to be the best preserved of the three known examples of this obscure organism. The hemispherical shape of the valve appears to have been undisturbed, and the form of its dorsal and ventral margins, with the flanged rim, to have escaped modification. The central and, as it were, umbilical depression, with its central tubercle, surrounding ridge, and vascular impressions, retain their shape; and the "nuchal" furrow, marking the dorsal region, is distinct. The thin line across the ventral region, and continuous with the sulcus, looks natural, and may be analogous to the perfectly transverse sulcus in *Entomidella*.

Entomis tuberosa is represented by some imperfect casts, and *E. Haswelliana* by others, in the same mudstone of the Pentland Hills that yielded Mr. Haswell's specimens (II. 1 and 2); and in some of them vascular radiation clearly accompanies the extremity of the dorsal "nuchal" furrow where it curves round a small central tubercle. Here is a close family resemblance; but *E. tuberosa* and *E. Haswelliana* are nevertheless Leperditioid in shape, the furrow is sinuous (not straight), and the central mark (muscle-spot) differs in definition and neatness. Regarding specimens I. and II. 2 as much modified by fossilization, and taking II. 1 as the type (so far as internal casts can serve), I think we have in these specimens the remains of a globular bivalved Entomostracan of the *Entomis* type; hence I proposed to term it *E. globulosa*. It is quite probable, however, that the exterior of the valve exhibited little or no furrow, and only a small central pit.

Some of the remarks on the German Devonian *Entomides*, in the Ann. & Mag. Nat. Hist. ser. 5, vol. iv., may be referred to as illustrating certain conditions of these little Palæozoic fossils; but we must add that fig. 16 of pl. xi. of that memoir, however similar in general appearance to one of the Pentland specimens, is not the same in actual condition, for it has been decidedly squeezed up from its usual oblong-ovate to a sub-globular form, with modified sulcus, pit, and cross-line; whilst, on the contrary, the tent-like Pentland fossil has its central area, with circular border and vascular radii, perfect and undisturbed, and was accompanied by another highly conical or subhemispherical specimen, and by several *Entomides* of species different from the foreign forms. "*Cypridina globulus*," Richter, is *Entomis serratostriata* (Sandberger), shortened by pressure, and thus squeezed into a globular form, and our fig. 3 of pl. xi. has also been squeezed end on.

We here figure (fig. 20), for comparison with fig. 13, one of the little Lower-Silurian fossils called "?*Cythere umbonata*" by J. W. Salter, 'Palæoz. Fossils Cambr. Mus.' 1855, Appendix A, p. ii; and described and figured by M'Coy in the same work, p. 138, pl. 1 E. fig. 6, as a Phyllopod, with an eye-spot on it—a feature which I do not at all recognize in any of the specimens I have examined. This little *Patella*-like fossil presents a seeming analogy, at first sight, to fig. 13; but its zoological alliances are quite doubtful at present. It is rather abundant in the Caradoc-Bala rocks of Pistyll Cwm-llech, Llanfyllin, and at Beudy Cerrig, Llanwddyn. Mr. Salter found it also in a bluish-grey schistose rock, belonging to the Llandeilo Flags, at Moel-y-Garnedd, Bala. Morris's Catalogue Brit. Foss. 1854, gives as its place, "*L. Sil.* Bala; Corwen; Conway Falls; Llanfurog."

8. *Entomis impendens*, Haswell. (Pl. XV. fig. 19.)

Entomis impendens, Haswell, Silur. Formation Pentland Hills, 1865, p. 38, pl. iii. fig. 11; Jones, Ann. & Mag. Nat. Hist. ser. 4, vol. xi. 1873, p. 415; H. Woodward, Catal. Brit. Foss. Crust. 1877, p. 120.

This little *Entomis* was originally figured in a book of limited circulation, and is therefore reproduced here for comparison. It occurs in the Upper-Silurian mudstone of Deerhope (?), in the Pentland Hills, as minute casts and impressions, often squeezed and closely resembling those of *Beyrichia impendens* in the same strata. *E. impendens* has suboval or nearly semicircular valves, with a definite dorsal sulcus, the umbilical end of which has its edges slightly raised and thickened; but this slight elevation of the rim of the furrow may be obsolete or quite absent. This little *Entomis* is not far removed from *E. reniformis* (p. 396) in its general character. Size $\frac{5}{25} \times \frac{3}{25}$ inch.

9. *Bolbozoe scotica*, sp. nov. (Pl. XV. figs. 15–17.)

The genus *Bolbozoe* was instituted by M. J. Barrande in 1868, and described in detail in 1872 (Syst. Silur. Bohême, vol. i. Suppl. p. 502). It contains several forms nearly related to *Entomis*, but having the anterior moiety of the valve raised into a definite, isolated, round tubercle, varying in relative size in different species. The dorsal sulcus of *Entomis* may be said to be here devoted to the formation of the posterior and concentric boundary of the relatively great tubercle of the bulbous anterior part of the valve.

Bolbozoe anomala, *B. bohemica*, and *B. Jonesi* are the Bohemian species, all Upper Silurian. The first (*op. cit.* p. 501, pl. xxiv. figs. 27–30) is almost matched by my "*Entomidella divisa*;" but in the latter the shape is more acutely ovate, and the tubercle is relatively larger; it must, however, be relegated to *Bolbozoe*. *B. Jonesi* belongs also to this division. For *B. bohemica* (*ibid.* p. 502, pl. xxvii. figs. 14–20) we have a most interesting analogue in some specimens from the Upper-Silurian mudstone of the Pentland Hills. M. Barrande gives figures of seven stages of his species here mentioned (from his Etage E e 2); and we can offer drawings of three apparently distinct stages of growth of our Scotch species. In this, as represented by internal casts, the anterior bulb or tubercle is not nearly so large as in *B. bohemica*, but the oblique shallow furrows on the hinder moiety of the valves*, characteristic of the latter species and making a second division of the genus, are present (figs. 15–17).

B. scotica remains to us as small internal casts, ovate, broad anteriorly and narrow behind, with a tubercle in front,

* This character was represented in Mr. G. C. Haswell's published sketch of what I afterwards called *Cyprosis Haswellii* (Geol. Mag. dec. 2, vol. viii. 1881, p. 338, pl. ix. figs. 6 *a*, 6 *b*), and M. Barrande was thereby led to regard it as being probably a *Bolbozoe* (*op. cit.* p. 501); but the Cypridinal notch removes it from this group.

and an undulating surface of the valve behind, impressed with one shallow, transverse, oblique valley in the young, and with two such impressions in the old stage. They were collected by Mr. G. C. Haswell in the Pentlands about or before 1866. Size $\frac{10}{25} \times \frac{6}{25}$ inch, and smaller.

10. *Bolbozoe divisa*, Jones. (Pl. XV. fig. 4.)

Entomis divisa, Jones, Mem. Geol. Surv. Scotl. 32, 1861, p. 137; and Month. Microsc. Journ. vol. iv. 1870, p. 185, pl. lxi. fig. 12.
Entomidella divisa, Jones, Ann. & Mag. Nat. Hist. ser. 4, vol. xi. 1873, p. 416; Woodward, Catal. Foss. Brit. Crust. 1877, p. 119.

This was separated from *Entomis* because its sulcus did not end at or near the centre of the valve, and it was placed with *Entomidella* because of the length of the sulcus, reaching to the antero-ventral border. Its direction, however, is not directly across, like that seen in *Entomidella*, and I ought to have referred the species to *Bolbozoe* in 1873, for this genus can take it in (see above, p. 400). The flattening which our figured specimen has received from pressure has greatly lessened the prominence of the anterior swelling. Size of valve $\frac{20}{50} \times \frac{10}{50}$ inch.

Bolbozoe divisa has been found in dark grey micaceous shale (Upper Silurian) at Cwm Craigddhu*, Builth, Breconshire, and in the Lower? Ludlow formation at Ludford†, Shropshire.

11. *Entomidella Marrii* (Hicks). (Pl. XV. fig. 21.)

Entomidella Marrii (Hicks), Jones, Report Brit. Assoc. for 1883, and Geol. Mag. dec. 2, vol. x. 1883, p. 464.

The genus *Entomidella*, instituted in 1873 (Ann. & Mag. Nat. Hist. ser. 4, vol. xi. p. 417), has a good type in *E. buprestis* (Salter), Quart. Journ. Geol. Soc. vol. xxviii. 1872, p. 183, pl. v. fig. 15; and now we have to figure another species, already noticed at page 8 of the "Report on Fossil Phyllopoda of the Palæozoic Rocks," presented to the British Association meeting at Southport in 1883, as having been observed on a slab (in the Cambridge University Museum) with *Caryocaris*, from the Upper-Arenig slates on the Nantlle tramway, at Pont Seiont, near Caernarvon. It has the long, convex, pod-like shape of both *Caryocaris Wrightii* and *Entomidella buprestis*, associated, however, with the transverse sulcus of the latter, from which it differs by being of smaller size and thinner at the ends. Surface smooth. It

* Cat. Pal. Foss. M. P. G. 1878, p. 130 ($\frac{2}{2}\frac{6}{?}$).
† In Dr. Griffith's Collection at Church Stretton.

is $\frac{5}{10}$ inch long, and $\frac{1}{10}$ high (wide). A similar form occurs in the Skiddaw Slates *.

EXPLANATION OF PLATE XV.

Fig. 1. *Entomis tuberosa,* Jones. Magnified 2 diameters. From a gutta-percha cast of a natural impression of the two valves, misshapen by pressure. Upper Silurian; Pentland Hills, Scotland.

Fig. 2. *Entomis depressa,* Salter, MS. × 2 diam. Internal cast of a pair of open valves, rather compressed. From the Aymestry Limestone; Mocktree, Shropshire.

Fig. 3. *Entomis depressa,* Salter, MS. × 2 diam. *a.* Internal cast of a pair of half-opened valves; *b.* Profile of one of the valves. From the Upper Ludlow; Aymestry Common.

Fig. 4. *Bolbozoe divisa* (olim *Entomidella divisa*), Jones. Natural size. *a.* Internal cast of the two opened valves, rather flattened; *b.* Profile. From the Upper Ludlow of Cwm Craigddhu, Builth.

Figs. 5, 6, 7. *Entomis tuberosa,* Jones. × 2 diam. Internal casts. Figs. 5 and 6, single valves; 7, a pair of valves: all misshapened by crush. Upper Silurian; Yarralumla, New South Wales.

Fig. 8. *Entomis Marstoniana,* sp. nov. Natural size. Two pairs (*a* & *b*) of valves spread open, lying side by side, and flattened. Lower Ludlow; Mocktree.

Figs. 9, 10. *Entomis Haswelliana,* sp. nov. 9. Internal cast, × 2 diam.; 10. The central part of another specimen, showing very fine lines radiating across the lower part of the sulcus, × 2 diam. Upper Silurian; Pentland Hills.

Fig. 11. *Entomis globulosa,* Jones. Internal casts. × 2 diam. *a.* Left? valve; *b,* central portion, × 4 diam.; *c,* dorsal view; *d,* ventral view; *e,* end view.

Fig. 12. *Entomis globulosa,* Jones. × 4 diam. Internal cast of a valve so much squeezed as to have had its dorsal sulcus made parallel with the long axis of the fossil. Upper Silurian; Girvan, Ayrshire.

Fig. 13. *Entomis globulosa* (?), Jones. × 2 diam. Internal cast of a conical valve, probably having relationship with the foregoing figs. 11 and 12. *a,* right? valve; *b,* ventral view; *c,* end view, the anterior? extremity. Upper Silurian; Pentland Hills.

Fig. 14. *Entomis Angelini,* sp. nov. Nat. size? Copied from fig. "10" of Angelin's unpublished plate "Tab. A," of Upper-Silurian Bivalved Entomostraca. *a,* left valve; *b,* edge view. From Gothland?

Figs. 15, 16, 17. *Bolbozoe scotica,* sp. nov. Nat. size. Internal casts, showing three stages of growth. Upper Silurian; Pentland Hills.

Fig. 18 (*a, b, c, d*). The internal cast of a Cypridinal (?) valve, accompanying figs. 5, 6, and 7. The inner figure and profiles are of the natural size; the outline surrounding the valve shows it magnified 2 diams.

Fig. 19. *Entomis impendens,* Haswell. × 4 diam. Internal cast. Upper Silurian; Pentland Hills.

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* Catal. Pal. Foss. M. P. G. 1878, p. 19 ($\frac{3}{13}$ tablet bears one specimen of this species); and one occurs in similar rock in the British Museum (Nat. Hist.), "no. 42162." They differ somewhat in size.

Fig. 20. "*Cythere? umbonata*," Salter. × 2 diams. Internal cast. Lower Silurian; Moel-y-Garnedd, Bala.
Fig. 21. *Entomidella Marrii* (Hicks). Nat. size. Right valve. Upper-Arenig Slates; Pont Seiont, Caernarvonshire.
Fig. 22. *Entomis reniformis* (Kolmodin). Nat. size. Lower-Ludlow Shale; Sedgley, Staffordshire.

XLIX.—*On new Species of Lepidoptera recently added to the Collection of the British Museum.* By Arthur G. Butler, F.L.S., F.Z.S., &c.

Nymphalidæ.

Euplœinæ.

1. *Trepsichrois Verhuelli*, ♂?

What I believe to be the male of this species has recently been received from North-east Borneo; it differs from *T. mindanensis* (which it most resembles) in the enlarged third subapical spot on the primaries; like that species it differs from *T. Linnei* in the absence of spots on the disk of the wing.

2. *Danisepa Schreiberi*, sp. n.

♂. The smallest species yet described; nearest to *D. Lowii*, but with the submarginal spots on the primaries wholly (or almost wholly) blue: secondaries darker and without a trace of the white stripes on the internal area either above or below. Expanse of wings 68 millim.

N.E. Borneo (*Dr. Schreiber*).

Papilionidæ.

Pierinæ.

3. *Teracolus Walkeri*, sp. n.

Allied to *T. Danaë*, but differing in the colour of the apical half of the primaries, which is crimson instead of magenta-red, and from all the species of the group in the great width (between 3 and 4 millim.) of the dark brown belt dividing the primaries of the male obliquely into two parts; the wings in both sexes are heavily suffused with grey at the base; both sexes have a decreasing series of squamose marginal spots on the secondaries, and the female has a straight discal series of small brown spots from costa to third median branch. On the under surface this species nearly resembles *T. Wallengrenii*, the secondaries, particularly of the female, being of a rosy flesh-colour. Expanse of wings 40–41 millim.

♂ ♀. Elephant Bay, south-west coast of Africa (*H. W. Walker*).

Presented to the Museum collection, with many other and new Lepidoptera, by J. J. Walker, Esq., one of the most energetic, painstaking, and liberal collectors whom it has been my good fortune to meet with for many years. Two pairs of this species were collected by his brother (after whom I have named it), and the more perfect pair was deposited in the national collection; the other specimens are larger.

Sphingidæ.

4. *Cephonodes Bucklandii*, sp. n.

Macroglossa Cunninghamii, Boisduval, Hist. Nat. Insectes Sphing. Ses. Cast. pl. ix. fig. 5 (1874).

Three examples. Port Darwin (*Buckland*).

This species is not the *M. Cunninghamii* of Walker, the latter being simply an Australian form of *M. hylas* and identical with (if not the type of) *M. gynx* of Boisduval; it is nearly allied to *M. Kingii* of M'Leay, but smaller, of a different shape (more resembling typical *Hemaris*), and the apical border of the primaries is dentated along its inner edge. *M. confinis* of Boisduval, a form closely allied to *M. Cunninghamii*, is said to be in the British Museum from Sierra Leone and Ashanti. But M. Boisduval is mistaken; we have only two examples which can be regarded as typical, and both are from Natal; none of our examples of *Cephonodes hylas* come from any of his other localities for this form.

Agaristidæ.

5. *Agarista biformis*, sp. n.

Allied to *A. agricola* and *A. dæmonis*; the male much like *A. agricola*, but differing in its more slender build, the smaller orange spots on its primaries, the more central position of the blue band on its secondaries, the narrowness of the carmine band, and the greater length of the white fringe; the female differs much more, the orange spots on the primaries being replaced by smaller cream-coloured spots, sometimes partly obliterated, the blue band on the secondaries straighter, better defined; the carmine band narrower and the white fringe of about three times the width. Expanse of wings, ♂ 61 millim., ♀ 72 millim.

One male and three females. Port Darwin (*Buckland*).

6. *Agarista ardescens*, sp. n.

Allied to *A. tristifica* (*A. Lewinii*, Boisd.). Upper surface black; primaries with a creamy-white basal fascia, a broader but similarly coloured subbasal fascia, and a costal dot between the two; a transverse oblong cream-coloured spot just beyond the middle of the cell, surrounded by an irregular metallic steel-blue marking, and a very irregular bisinuated abbreviated band placed obliquely beyond the cell (as in *A. polysticta*); an abbreviated discal series of seven white dots halfway between the band and the outer margin, two white dots placed obliquely beyond the middle of the internal area; a submarginal series of white dots, terminating with a larger incised cream-coloured spot near the external angle; interno-median area suffused with dark lurid red: secondaries browner than the primaries; fringe long, snow-white, spotted with black, excepting towards the anal angle: head and thorax striped with white; metathorax, base of abdomen, and last two segments of abdomen ochreous. Under surface dark brown, with purplish reflections: primaries with the base whitish; frenulum held in position by a little subbasal testaceous tuft projecting upwards over the median vein; two quadrate spots in the cell; a bisinuated oblique band beyond the cell and a spot near external angle cream-coloured: secondaries with the extreme base ochreous, otherwise as above: palpi cream-coloured, banded with black; thorax ochreous; tarsi of all the legs and tibiæ of front pair black, banded with white; venter greyish in the centre, black at the sides; anus ochreous. Expanse of wings 44 millim.

Port Darwin (*Buckland*). Type B. M.

In some respects this species is intermediate between *A. tristifica* and *A. ephyra*, but it is probably most nearly allied to *A. polysticta*.

7. *Agarista vindex*, sp. n.

Near to *A. affinis* (from Sydney, Port Macquarie, &c.), but the primaries narrower, the yellow belt paler, more oblique, less incised, and shorter, as broad as in the best-marked specimens of *A. affinis*; white discal dots obliterated; secondaries with narrower fringe, bluish spots on under surface darker; abdomen above steel-grey instead of black. Expanse of wings 34 millim.

Queensland.

This appears to be the northern representative of *A. affinis.*

8. *Agarista darwiniensis*, sp. n.

Near to *A. Donovani*, which the female almost entirely agrees with on the upper surface, excepting that the yellow spots on the primaries are smaller, the fringe less distinctly spotted with white, and the abdomen ochreous with black bars (not barred with whitish); the ground-colour of the wings in both sexes is, however, much darker (purplish chocolate, almost black), and the band across the secondaries of the male is much narrower on the under surface; the wings are purplish black instead of shining chocolate-brown, the costal margins are not yellow, as in *A. Donovani*; the yellow markings are all smaller, narrower, and more uniform in colour, the inner spot on the discoidal cell of the primaries is obliterated, the fourth spot of the oblique central series is also obliterated, the band on the secondaries shows no trace of white suffusion, and the basal yellow streaks are obliterated. Expanse of wings 54–60 millim.

♂ ♀. Port Darwin (*Buckland*).

We also possess two apparently dwarfed examples of what I take to be a slight variety of this species collected in N. Australia by J. R. Elsey, Esq.

Nyctemeridæ.

9. *Pterothysanus lanaris*, sp. n.

Allied to *P. laticilia*, but the white spots on the primaries enlarged, more especially in the submarginal series; secondaries with the discal lunulated black belt narrower, abbreviated, not extending beyond the second median branch, the third lunule separated from the fourth, the second and third median branches not being blackened, so that the discal and submarginal markings are only connected by the blackening of the subcostal branches; submarginal and marginal black spots smaller and less confluent. Expanse of wings 44 millim.

Shanghai? Type Brit. Mus.

The type was labelled "E. India," but on referring to the register, I find that the specimens were from "Shanghai, N. India, New Grenada," &c. As we know the species of the N.E. Himalayas to be *P. laticilia*, and as "N. India" in the old registers usually stood for Silhet or Assam, the probability is that *P. lanaris* is from Shanghai.

10. *Pterothysanus pictus*, sp. n.

Wings above snow-white; primaries with the base and costal border black, with three equidistant white spots between the end of the cell and the apex; a black rounded spot in the cell and an angular almost 3-shaped black band from just beyond it to the inner margin; a very irregular band made up of confluent black spots from the costa beyond the middle to the second median vein, where it is completed by the addition of an isolated spot and a dot of the same colour; two partly confluent subapical series of three black spots, the outer series connected by a black line to the first submarginal spot; three unequal small spots also stand below the two subapical series, and form an unequal triangle; seven submarginal black spots in a decreasing series; nine marginal black spots extending into the fringe and with a series of rust-red spots between them: secondaries crossed at basal third by three unequal black spots; a somewhat falciform series of five spots (the third and fourth being thrown much forward out of line) about halfway between the first series and the outer margin; a submarginal series of seven black spots and five marginal spots extending into the fringe and alternating with rust-red spots, as on the primaries. Body as in *P. laticilia*: secondaries below with the costa black; otherwise as above. Expanse of wings 60 millim.

Elephanta Island.

The red marginal spots in this species fully confirm my view of the affinities of the Mascarene genus *Caloschema*, Mab., which unfortunately was described almost simultaneously with my *Helicomitra*, which it supersedes.

L.—*Descriptions of two new Moths from Madagascar.* By Arthur G. Butler, F.L.S., F.Z.S., &c.

The species here described were selected from a large series of Lepidoptera collected by Mr. Thomas Waters in the Betsileo country.

Sphingidæ.

Ambulyx Watersii, sp. n.

Allied to *A. Grandidieri* of Mabille. General colour above pale sandy brown, the primaries somewhat greyish between the bands; base suffused with snowy white, which passes gradually into the ground-colour; a black subbasal spot and an interno-basal black spot upon the long scales below the submedian vein; other markings indistinct, as follows:—a zigzag brown line crossing the wing just before the basal third, an irregular belt inarched at the extremities and tapering towards the inner margin, before the middle; a minute brown litura upon the lower discocellular veinlet; an oblique belt, its inner edge zigzag, below the median vein, bounded on each side and traversed through the middle by brown lines; external fourth occupied by a broad smoky-brown border, upon which the veins are barred with dark brown and white: secondaries tinted with pink below the median vein; a large pyriform black basal patch from the middle of the cell to the abdominal margin, and a broad black band tapering at the extremities from costa to first median branch and parallel to outer margin; between these two black markings is a widely sinuous smoky-brown stripe, most sharply defined at abdominal margin, where it bounds a snow-white anal patch crossed by a curved abbreviated black line; edge of outer margin dusky, tips of fringes at anal angle black: thorax sordid white, tegulæ slightly tinted with pink; a blackish longitudinal stripe commencing on the top of the head, gradually narrowing to a line as it passes across the collar, and ceasing at about the middle of the thorax; antennæ white at the base; abdomen flesh-coloured, with diffused sandy olivaceous dorsal patches, excepting on the anal segment. Under surface rosy brownish; the primaries with a tapering subcostal whitish streak from the base and an oblique blackish streak from inner margin to median vein; a faint greyish undulated line beyond the cell from costa to first median vein; veins towards outer margin barred with black; a broad external white patch, tapering at each extremity: secondaries paler than primaries, whitish towards the base; a dentate sinuate dusky line bounding the external area, which is as dark as the primaries; the veins immediately beyond this line barred with black: thorax for the most part whitish, but the palpi, prothorax, and legs rufous-brown, the hind legs, and especially the spurs of these legs, varied with black and white; venter flesh-tinted, whitish at the sides. Expanse of wings 107 millim.

Betsileo country (*T. Waters*). Type Brit. Mus.

Agaristidæ.

Eusemia Watersii, sp. n.

Most nearly allied to *E. Belangerii* from Java and *E. zea* from Madagascar. Primaries dark chocolate-brown, crossed beyond the middle by an oblique primrose-yellow band, which does not reach the margins; a white dot on the fringe at apex: secondaries black, with chocolate-brown reflections; a large rounded carmine patch occupying the whole central area, from the subcostal vein to the abdominal margin; its extreme edge towards costa ochraceous; abdominal fringe also ochreous at the base; fringe of outer margin white at apex: head and collar black, spotted with primrose-yellow; thorax black; abdomen ochreous, crossed by black lines, which emit a dorsal tapering stripe on each segment, last two segments almost wholly black; legs, base of wings below, and under surface of body bright ochreous. Expanse of wings 56 millim.

Betsileo country (*T. Waters*). Type Brit. Mus.

LI.—*Local Colour-varieties of* Scyphomedusæ: *a new Species produced in Forty Years.* By R. von Lendenfeld, Ph.D.

The colours of the large Medusæ are as variable as they are brilliant, and we generally find the same species in a long series of finely-toned colour-varieties.

I have observed two species of large Medusæ (*Cyanea annaskala*, R. v. L., and *Crambessa mosaica*, H.), which, although they vary very much in their colour, do not appear in a series of connecting varieties, but rather as "beginning species," inasmuch as the colour in these varieties is quite constant in the different-coloured Medusæ met with in different localities.

I have found these two species in Port Phillip, south coast, and in Port Jackson, east coast. Although these two places are not far apart, still the water is very much warmer in the latter harbour than in the former. This is owing to the nature of the ocean-currents. A warm equatorial current which passes along the eastern coast of Australia supplies Port Jackson with warmer and, probably, salter water than that with which Port Phillip is filled. A cold polar current flows past the entrance to Port Phillip.

I have found occasion to draw attention to the fact that *Crambessa mosaica* in Sydney was brown, whilst in Melbourne the same species always appeared deep blue. The brown colour is not always of the same depth and of similar hue all over the surface of the Medusa, but varies from the colour of white bread to that of coffee. The cause of this colour is to be found in small yellow cells, which appear in more or less dense clusters all over the surface. These cells are parasitic Algæ known as *Zooxanthella*. It does not appear unlikely that they may be the young stages of ordinary Laminarians.

Such *Zooxanthellæ* are very common in jelly-fish, sponges, &c., all over the world. Also in Port Phillip I obtained numerous Actiniæ which were infested by them. The *Crambessa mosaica* of Melbourne, however, never shows a trace of a *Zooxanthella*, and so retains its original blue colour.

In the harbour of Sydney, on the other hand, *Zooxanthellæ* which appear identical with those in Melbourne are found in great masses in *all Crambessæ*. In Sydney as well as in Melbourne I had occasion to see many thousand specimens, and I found that the Melbourne variety was always blue, but that the Sydney species was not absolutely always quite brown.

With the trawl we sometimes brought up *Crambessæ* from depths of 10 or 20 metres which did not show the brown colour very distinctly, and it appeared that only a few masses of *Zooxanthellæ* could be detected with the magnifying-glass. In every case some yellow cells were present.

I think that I might be justified in considering the difference between the Sydney and Melbourne species as sufficient to make two varieties of them.

In the cold water of Port Phillip it appears not to be advantageous for the Medusæ or the Algæ to live symbiotic, whilst this does appear to be the case in the warm water of Port Jackson. The Melbourne variety, which I name *Crambessa mosaica conservativa*, is blue, and has apparently retained the habits of its ancestors. The Sydney variety, which I shall name *Crambessa mosaica symbiotica*, has given up this mode of life, and has taken to live together with a *Zooxanthella*. The difference between the two is evidently the same as that between fungi and lichens. Should the variety *symbiotica* adapt itself, in the ordinary course of natural selection, so wholly to this symbiotism as not to be able to live without the *Zooxanthella*, a new species will have been formed, which may perhaps be the case already.

Crambessa mosaica has been described by several authors. All the specimens were collected near Sydney, and the species is described as blue to grey. No one mentions the bright brown colour, which is so very striking. The latest of these observers was T. Huxley, in the year 1845. Has the change taken place since that time? Have we to assume that a new species or variety has been produced within the last forty years?

If this paper should be read by any one who has access to the original type specimens of Quoy et Gaimard or Huxley it would be well worth while to examine them, so as to find out whether they can detect any *Zooxanthellæ* in them or not.

Two years ago I described a most beautiful Medusa of Port Phillip as *Cyanea annaskala*, R. von L. Although this species appears in millions in the place mentioned, there is no record of its having been found anywhere else, and I also have not found it in any other locality until lately. In September a few specimens appeared in Port Jackson, which, though slightly different in colour and size, must doubtlessly be referred to my species *Cyanea annaskala*. Whilst the Melbourne specimens appeared never to grow beyond 10 centims. in diameter, the Sydney specimens attain a diameter of 20 centims. and more. There is hardly a doubt that this Medusa grows to a larger size in the warmer water of the equatorial current than in the cold water that comes from the South Pole, the fauna of which is comparatively poor. There exists also a difference in the colour of the mouth-arms. The Melbourne specimens possess mouth-arms which are deep purple throughout, whilst the purple colour in the Sydney specimens is found only at margin.

The margin, which is much thicker than the proximal parts of the mouth-arms, consists of a number of cells in the ectoderm, which is here composed of many layers. The pigment is found in these cells exclusively, and not also in the supporting lamella, as in the Melbourne specimen.

Among the thousands of specimens which I examined at Melbourne I did not find a single form which might be considered as a transitional variety. The mouth-arms of all had quite the same colour—a fact to which I drew attention at the time, as also the few Sydney specimens which I found were constant in this particular. I consider myself justified in setting up provisionally two varieties of this species:—

Cyanea annaskala purpurea, found as yet only in Port Phillip, with mouth-arms which are richly purple throughout; and *Cyanea annaskala marginata*, found as yet only in Port Jackson, with mouth-arms which are purple at the free margin, but otherwise appear colourless.

The purple colour in the mouth-arms is very similar to the brilliant purple ("Sehpurpur") in the sensitive apparatus of the retina of some animals, particularly the lizard. When the *Cyanea* is placed in a glass aquarium this colour fades in less than an hour to a dirty brick-red. When the Medusa is sick, even in the open sea, it is always this colour which is affected first, and turns into a dirty coffee-colour long before the tentacles begin to drop off, which is always a sign of approaching death.

In my paper on the structure of *Cyanea annaskala* I pointed out that no pigment occurs in the marginal bodies, and that therefore the organs of sight of this species, if to be found in the marginal bodies at all, were not nearly so highly developed as in the other Medusæ, or even as in other species of the same genus which *do not possess purple mouth-arms.*

Sensitive cells are very numerous, particularly in the purple margin, and *contain* the purple substance. Ganglion-cells are also met with there. The pigment in the other parts might be considered as reserve material for that which may perhaps be used up by the sensitive cells. I do not go so far as to draw the conclusion which the reader will have inferred from the preceding lines; but I should like to hint at the possibility of the mouth-arms of our Medusa being able to perceive light.

LII.—*Notes on Hawaiian Neuroptera, with Descriptions of new Species.* By the Rev. THOMAS BLACKBURN, M.A.

SOME years ago I sent a small collection of Hawaiian species of this order to Mr. McLachlan, concerning which a remarkably interesting paper from that gentleman's pen appeared in the Ann. & Mag. Nat. Hist. for October and November 1883. It was at the time a matter of much regret to me that the number of specimens I was able to send Mr. McLachlan was very meagre, owing, I think, to the fact that the Neuroptera occupy only a secondary place in my studies, rather than to their being of rare occurrence on the archipelago. Since the appearance of the above-mentioned paper my scanty leisure time has been devoted to describing new Hawaiian Coleoptera; but as that work is now completed (so far as my materials go), I think it might not be without interest if I were to pass in review the results of my exploration, not hitherto published, in the other orders. In doing so I shall not attempt to name and describe species, except where they happen to have very salient characters, but shall content myself with indicating their affinities in general terms, leaving their more precise disposal for the possibilities of the future. I propose to furnish a paper on the Neuroptera first, and to arrange that paper in the form of some remarks on each of the families recorded as Hawaiian.

PSEUDO-NEUROPTERA.

Termitidæ.

I have not met with any more than the two American species recorded in Mr. McLachlan's paper. They are both extremely common near Honolulu, flying in numbers to lamps at night, and doing much damage in the destruction of furniture and other woodwork, also frequently destroying trees. Without having given sufficient attention to the subject to generalize with absolute confidence, I may say that the Termitid connected with *household* depredations, when identified by me, has always been *Calotermes castaneus*, Burm. (which, moreover, I have not observed outside Honolulu), while the *tree* devastator when identified has always been *C. marginipennis*, Latr. This latter species I have observed on several of the islands and occasionally in remote parts of the forests.

Embiidæ.

The single Embiid I have noticed (*Oligotoma insularis*, McLachl.) seems to be widely distributed. It is a common visitor to lamps at night. I have frequently discovered it feeding in numbers in old wooden roofs of houses, but do not remember meeting with it elsewhere, though doubtless this is merely the result of insufficient observation.

Psocidæ.

Of these I have three or more species allied to that which Mr. McLachlan considers may be *P. bifasciatus*, Latr., but no other near *Elipsocus vinosus*, McLachlan. These insects were all taken from dead branches of trees in the forests, where they abound.

ODONATA.

Pantala flavescens, F., *Tramea lacerata*, Hag., and *Anax junius*, Drury, are all very common all over the islands.

I have a single specimen taken on Maui which I have no doubt is *A. strenuus*, Hag. The expanse of its wings is just about a quarter greater than that of my largest *A. junius*. Its colour is much darker, noticeable especially in the nervures of the wings, which are quite black. It is a male, and its *genitalia* differ from those of *A. junius* as follows:—Of the superior appendages the apical spine is very much shorter and less acute, and the angles at the two points where the internal edge of the appendage is successively contracted are much more rounded off. The plate which forms the inferior surface of the lower appendage is darker in colour and not wider than long (viewed from beneath), and there are only two *very obtuse* teeth on the upperside. There can be little doubt of the distinctness of this species from *A. junius.* My specimen was captured at an elevation of more than 4000 feet. The species is very strong on the wing, and very shy and difficult to capture. I have seen what appeared to be specimens of it frequently, but always at a considerable elevation, on the higher mountains. It is a really magnificent dragon-fly.

Agrionina.

Of these I possess several species, which I shall venture to describe as follows:—

Agrion? satelles, sp. nov.

Allied to *A. calliphya*, McLachl. The pterostigma is smaller, surmounting scarcely more than one cellule. The quadrilateral is less elongate, its upper edge being not more than half the length of the lower in both pairs of wings. Postpterostigmatic cellules irregular (in one of my specimens they form a single row on the posterior wings, in the other they are partially duplicated, but on one posterior wing more than on the other). Three cellules between the quadrilateral and the nodus.

Prothorax obscurely spotted with red (I have a specimen of *A. calliphya* in which the same part has some red spots).

Hind body red, with only some obscure black markings.

In the male the hind margin of the tenth segment is strongly excised semicircularly. The superior appendages are longer than the segment, stout, blackish, pointed at apex, greatly dilated at base, without a basal tubercle. Inferior appendages very little shorter, red, with black tips, very strongly curved upwards.

Female unknown.

Length of hind body, ♂ 35 millim.; length of posterior wing 22 millim.; expanse 50 millim.

This species occurs on Haleakala, Maui, at an elevation of about 4000 feet above the sea.

Agrion? oahuense, sp. nov.

Another ally of *A. calliphya*, McLachl. Pterostigma lozenge-shaped, surmounting two (on one side in my specimen it surmounts more than two) cellules, blackish. Quadrilateral elongate, with its superior edge one third the length of the lower in the anterior wings, nearly a half in the posterior. About twenty postcubital nervules in anterior wings; about fourteen in the posterior. Three cellules between quadrilateral and nodus.

Head and thorax black. Hind body bright red. Labium, labrum, and extreme hind margin of head yellow. Posterior margin (which is rounded) of prothorax and some spots on the disk yellow. Thorax with a narrow dorsal elevation, an antehumeral band, and the lower portion of the sides, yellow. Pectus yellow. Legs yellow, with the spines black. Hind body bright red, apical sixth of third and fourth and nearly the whole of the fifth to eighth segments pitchy. An elongate dorsal impression near the apex of the third to fifth segments; ninth and tenth segments red.

♂. Tenth dorsal segment of hind body very strongly elevated from the base backwards, so that (viewed from the side) it appears much higher at the apex than the base, abruptly truncate behind, the hind margin strongly pubescent. The superior appendages are pear-shaped in outline, but concave; they are contiguous at the base, with the broad ends in contact, and are laid flat along the truncate hind surface of the tenth segment, so that the narrowed ends point out sideways, with their concavities facing backwards; the narrowed ends are somewhat turned upwards and backward. The upper half of these appendages is black, the lower half red. The lower appendages are small, conical, red, with black tips.

Female unknown.

Length of hind body, ♂ 40 millim.; length of posterior wing 22 millim.; expanse 50 millim.

This species is remarkable for the length of its hind body, which is so great that the total length of the insect is scarcely less than the expanse of the wings.

A single specimen occurred on Oahu, but the exact particulars of its capture have been lost.

Agrion? nigro-hamatum, sp. nov.

Another of the *A. calliphya* group. Pterostigma reddish brown, surmounting scarcely more than one cellule. Quadrilateral with its superior edge not quite (in the anterior wings), just about (in the posterior), half the length of the lower.

Fourteen postcubital nervules in anterior wing, twelve in posterior. Three cellules between quadrilateral and nodus.

Colour dark bronzy green above, testaceous beneath.

Labium, labrum, and a narrow line along back of head (which is fringed with yellow hairs) not quite reaching the eyes, bright yellow. Posterior margin of prothorax (which is elevated and rounded) and some obscure spots yellow. Thorax with a well-defined elevated central line, a broad antehumeral line, and some broad lateral lines, yellow. Pectus yellow.

Legs bright yellow, with the knees, tips of tarsi and of claws, and the spines intensely black.

Hind body with segments 1–8 narrowly edged with testaceous colour at base; segments 9 and 10 entirely pale brown.

♂. Tenth segment very strongly and triangularly emarginate. Superior appendages yellow, with the apex black. These appendages are strongly compressed and of almost uniform width (viewed from the side) to the apex, where they are sharply hooked, the hook pointing downwards. The lower appendages are conspicuously longer than the upper; they are broad at the base (viewed from the side) and contracted to beyond the middle, from which point they are slightly dilated again and turned upwards, terminating each in two short sharp spines; they are yellow, with the tips black.

Female unknown (subject to the N.B. below).

Length of hind body, ♂ 40 millim.; length of posterior wing 22 millim.; expanse 55 millim.

A single specimen occurred on Maui, but details of the capture are lost.

N.B.—I have three specimens taken in the Nuuanu valley, Oahu, which differ from the above insect as follows:—The markings on the head and thorax are more obscure and of a dirty testaceous colour; the upper edge of the femora is black, and the tenth segment in the male is less strongly excised; the apical segments of the hind body are coppery rather than brown in tint (in one specimen this colour extends to the eighth segment of hind body as well as the ninth and tenth, and in another it is almost confined to the tenth). The genitalia of the female do not differ much from those of female *A. hawaiiense*, McLachl., save that the appendages of the valvules are red and the tenth segment has a more distinct longitudinal dorsal elevation. The male appendages have such strongly marked characters in common that I think the specimen taken on Maui (described above) and these Oahuan specimens must be regarded as local races of a single species in spite of their differences, especially since the Oahuan specimens differ in colouring *inter se*; but it is quite possible I may be mistaken in this opinion.

Agrion? koelense, sp. nov.

This insect appears to me nearer *A. hawaiiense* than any other known to me. Pterostigma surmounting rather more than one cellule. Quadrilateral with its superior edge about half the length of the lower in both pairs of wings. About fifteen postcubital nervules in anterior wings, about thirteen in posterior. Three cellules (rather more in the anterior wing on one side of my specimen) between the quadrilateral and nodus.

Colour entirely steely black, save the labium, which is dull testaceous. Here and there the colour shades off into steely blue.

♂. Tenth segment gently and triangularly excised. Superior appendages strongly compressed, forcipate; viewed from the side each of them has the appearance of a parallelogram, of which the upper apical extremity is produced into a long and the lower into a short process; in reality, however, these processes are turned inwards before their extremity and terminate in spines. The lower appendages are not much shorter than the upper, and are strongly dilated at the base, but pointed at the apex, the points being directed upwards and inwards.

♀. My specimen is so badly mutilated as to be insufficient for description. The upper appendages of the *genitalia* are wanting; the remaining parts of them, however, are entirely black.

Length of hind body, ♂ 35 millim.; length of posterior wing 22 millim.; expanse 50 millim.

Two specimens occurred on Lanai, flying in a ravine near a place called Koele.

Agrion? pacificum, McLachl.

I observe that in Mr. McLachlan's paper the localities where this species was taken are said to be "Lanai and Oahu." This is, unfortunately, a mistake, very likely a slip of the pen on my part. The islands on which I met with the species were Maui and Lanai.

PLANIPENNIA.

Hemerobiidæ.

I see Mr. McLachlan (for want of sufficient evidence) justly hesitates to consider the *Megalomus* I sent him endemic. I feel no doubt, however, that species of this family (and probably a good many of them) are strictly endemic. It will readily be believed that an entomologist not making the Neuroptera a specialty would be unlikely to do justice in his collecting to a group of flies so obscure as this; yet I have three, if not four, distinct species in my scanty collection of Hawaiian Neuroptera. Moreover, I doubt much whether I have seen any of the family very near to any place whither imported plants or shrubs would be taken, and can say quite positively that they are far more numerous at a considerable elevation in the mountain-forests than elsewhere. I have taken Hemerobiidæ on Oahu, Maui, and Hawaii, and have a strong impression of having *seen* them on Kaui, Molokai, and Lanai. I shall not attempt to describe any of them, as I have neither literature nor special knowledge of the family sufficient to justify me in doing so. None of them appear to me very remarkable or very different from European forms.

Chrysopidæ.

This family is richly represented in the Hawaiian archipelago, and probably there are scores of distinct species. I think I have met with examples on every island, and in all kinds of localities, often in considerable abundance.

There are three species in my collection which I shall venture to describe as possessing strongly marked characters not likely to be capable of confusion with those of other species.

Anomalochrysa Maclachlani, sp. nov.

Body, legs, palpi, and antennæ pale reddish yellow, the hind body being darker towards the apex; basal joint of antennæ strongly bulbose.

Pronotum decidedly longer than broad, moderately narrowed anteriorly. The posterior angles considerably produced backwards; a deep (though fine) transverse impression a little behind the middle.

Thorax with the surface extremely uneven, consisting of large smooth bulbous tubercles.

Hind body of the male clothed with long fine hairs (very easily rubbed off). The terminal segment forms a large oval plate, concave above, with the lateral margin strongly turned up and abruptly thickened in the middle; the posterior margin only slightly raised. The ventral plate, forming the under surface of this portion of the hind body, is considerably longer than broad, and is of a somewhat triangular shape, its base being of the width of the upper plate and its apex much narrower, strongly rounded and turned upward to meet the apex of the dorsal plate. Between the two plates (but not protruding from them) a blackish organ can be perceived, but it is too completely folded between the plates for its form to be ascertained.

Wings of the appearance of thin plates of ivory, white, with a strong greenish opaline lustre. Neuration nearly of the same colour, and therefore not conspicuous. The neuration is furnished, as in *A. hepatica*, McLachl., with rather long hairs, which, however, are of an obscure colour and excessively fine. The neuration does not appear to me to differ noticeably from that of *A. hepatica,* but, owing to its colour, it is difficult to make out. There are evidently five series of gradate nervules, of which the first consists of nearly twenty and the fifth of about ten nervules (the intermediate ones being much confused), and there are upwards of thirty antepterostigmatic costal nervules. The wings are somewhat more pointed than those of *A. hepatica*, and the posterior pair are evidently broader in proportion.

♀. Unknown.

Length of body 13 millim., expanse 30 millim.

I took two specimens of this remarkable insect on Mauna Loa, Hawaii, flying by day at an elevation of about 6000 feet, in May 1882.

Anomalochrysa montana, sp. nov.

Body, legs, palpi, and antennæ testaceous; pronotum and thorax with a brilliant longitudinal scarlet line; head more or less suffused with red. Basal joint of antennæ strongly bulbose.

Pronotum longer than broad, narrowed anteriorly, with a transverse impression near base.

Hind body of male clothed with hairs; the last segment is in the form of a plate, which is placed upright at a right angle, or nearly so, to the hind body (it is *possible* that this plate may have been contorted at the death of the insect into the position described, though it is so in all my six male specimens). The plate is of an oval shape and is concave on both sides, owing to its much thickened margin. The ventral plate corresponding is triangular and a little turned upwards at the apex.

The wings are vitreous, with an opaline lustre and well-defined neuration; the nervures are all of a greenish colour and are set with long black hairs; the pterostigmatic region is obscurely greenish. There are three series of gradate nervules in both pairs of wings, consisting of about 9, 7 and 8, 7 nervules respectively (the number, however, varies and does not appear to be sexual). There are about twenty-three antepterostigmatic nervules.

Length of body 8–10 millim.; expanse of male 22–25 millim., female 26 millim.

I captured a short series of this insect flying by day in a forest on Mauna Loa, Hawaii, at an elevation not much under 7000 feet, in May 1882.

Anomalochrysa ornatipennis, sp. nov.

Body, legs, palpi, and antennæ liver-coloured, the hind body being darker. Basal joint of antennæ bulbous. Pronotum transverse, with two strong transverse dorsal impressions.

♂. Characters unknown.

Wings vitreous, shining, iridescent; neuration dark brown and very conspicuous, studded throughout with long black hairs. Pterostigmatic region very conspicuous, liver-coloured, marked with three (in the anterior wings) or two (in the posterior) well-defined nearly black spots. Three series of gradate nervules in the anterior wings (in the right wing there are traces of an additional series between the first and second), consisting of 8, 4, and 4 nervules respectively; about seventeen antepterostigmatic costal nervules.

Length of body 6 millim.; expanse, female, 22 millim.

A single specimen of this insect occurred to me on Mauna Loa, Hawaii, at an elevation of about 4000 feet. Although it is a female, the remarkable and conspicuous marking of the wings justifies its being described and named. It bears a considerable general resemblance to *A. hepatica*, McLachl.

Besides the above, I possess the following Chrysopidæ:—

(*a*) A single female specimen of an ally of *A. Maclachlani*, captured on the mountains near Honolulu. It is conceivable that it may be the female of the same species; but as it differs somewhat in colour, being of a uniform yellowish *white* (wings included), and has the thorax less elongate, the basal joints of antennæ much more bulbose, &c., I have little doubt that it represents a distinct, though rather closely allied, insect.

(*b*) A species allied to *A. montana*, but much smaller, and without the scarlet markings. A single male occurred on Haleakala, Maui, and as its sexual characters do not seem to differ much from those of *A. montana*, I hesitate to consider it a distinct species.

(*c*) A rather distinct-looking species allied to *A. hepatica*, McLachl., and resembling it in colour, though with the neuration of the wings quite obscure. It has three series of gradate nervules on the anterior wings. I do not venture to name it, having only a female specimen, which I captured on Haleakala, Maui.

Myrmeleontidæ.

It seems a singular thing that I have met with the one species of this family known as Hawaiian only in a single ravine on Maui, though there it is common enough, and so conspicuous as to seem incapable of escaping notice. It is fairly strong on the wing.

In conclusion I will just say that the non-existence or (more probably) rarity of the Trichoptera is in accord with the state of affairs in other orders. All water-frequenting insects are scarce, the described Dytiscidæ being represented by three (one of which is unique), the Hydrophilidæ by one, and the true water-bugs by two species respectively. There scarcely can be said to be any constant fresh water on the islands. I am not aware of any permanent natural freshwater lake; at any rate, the only one I know that is probably permanent is at an elevation of near 15,000 feet above the sea. (When I visited it, it was frozen over.) There are springs here and there, one of which was a favourite hunting-ground with me, as its moisture attracted insects to the neighbourhood; but I feel sure that no Trichoptera occur there. There are also *streams* which do not absolutely disappear in dry seasons; but the natural state of the islands, apart from modern arrangements for the artificial preservation of water, is that of possessing very little permanent water really fresh. On one of the islands (Lanai) it is said that the horses and other animals do not know how to drink. The comparative abundance of Agrionidæ is remarkable, and I know not how to account for it.

Port Lincoln, South Australia, Oct. 1884.

LIII.—*Contribution to our Knowledge of* Hydromedusa, *a Genus of South-American Freshwater Turtles.* By Dr. A. Günther, F.R.S.

[Plate XIV.]

Having recently received a very well-preserved and interesting specimen of *Hydromedusa* from fresh waters south of the Rio de la Plata, I have been induced to examine the history of this genus, the species having lapsed into a singular state of confusion from the time in which the genus was established by Wagler (Syst. Amphib. 1830, p. 135), who confounded the species seen and figured by him with that which had been so well described and figured in Mikan's Delect. Flor. et Faun. Bras. In this he was followed by Duméril and Bibron, Gray, and other subsequent writers.

Hydromedusa.

Shell much depressed, with six scutes in the vertebral series and twenty-four marginals. Sternum solid, the two middle scutes directly forming a suture with the marginals, without axillary or inguinal scutes. Median gular very large, deeply penetrating between the postgulars. Neck long; head depressed, covered with skin, which, however, is divided into numerous small scutes. Mouth of moderate width; jaws narrow, with a horny sheath. Eye of moderate size. Limbs covered with granular skin, with a few transverse scutes. Four claws only, in front and behind. Tail very short.

System of the Plate River and the country intervening between it and the Atlantic coast.

The species known to me at present can be readily distinguished thus:—

1. *Hydromedusa Maximiliani* (Mikan).

Emys Maximiliani, Mikan, *l. c.* c. tab.
Chelodina flavilabris, Dum. & Bibr. p. 446.
Chelomedusa flavilabris, Gray, Ann. & Mag. Nat. Hist. 1873, xi. p. 304.
Hydromedusa Bankæ, Giebel, Zeitschr. Ges. Naturw. 1860, xxvii. tab. iv.

Shell very flat; dorsal scutes without tubercles at any age. Nuchal comparatively small; first vertebral large, with a concave anterior margin, and intervening between the nuchal and first costal.

A small species which is fully adult with a shell six inches in length, from the province of San Paulo (Brazil). Giebel's statement that the type of *H. Bankæ* came from the island of Banka must rest upon some mistake. I have examined four specimens, which show that the character taken from the shape of the first vertebral scute is constant; they fully agree with Mikan's very good and Giebel's rude figure.

2. *Hydromedusa depressa* (Gray).

Hydromedusa depressa, Gray, Cat. Shield Rept. p. 60, tab. xxvi.
Hydromedusa subdepressa, Gray, Proc. Zool. Soc. 1852, p. 134.

Shell very flat; dorsal scutes without any tubercles. Nuchal large and slightly in contact with the first costal.

Brazil. The specimen which is the type of *H. depressa* as well as of *H. subdepressa* is still the only individual known of this species.

3. *Hydromedusa Wagleri*, sp. n.

Hydromedusa Maximiliani (nec Mikan), Wagl. Syst. Amphib. p. 135, tab. iii. figs. 25–42; Gray, Cat. Shield Rept. p. 59.
Chelodina Maximiliani, Dum. & Bibr. p. 449 (part.).

Tuberosities are persistent throughout life on the last two vertebral and costal scutes. Nuchal very large and broad and in contact with the first costal, the first vertebral having an oblong form (but being only three fourths as wide as long).

An adult male with a shell 7 inches long, in the Natural-History Museum, from Buenos Ayres, agrees well with Wagler's figure and with the description of one of the two specimens given by Duméril and Bibron, who also assign Buenos Ayres as the native country of this species.

It is very probable that *Hydromedusa tectifera*, Cope (Proc. Am. Phil. Soc. 1869, p. 147), from the Parana *or* Uruguay, is identical with this or the following species, in which case the name given by Cope would have priority. Although Cope describes the forms of the nuchal and first vertebral (the latter being nearly twice as long as wide), he omits to say whether or not the nuchal is in contact with the first costal.

4. *Hydromedusa platanensis* (Gray).
Pl. XIV.

Chelodina Maximiliani (nec Mikan), Dum. & Bibr. p. 449 (part.).
Hydromedusa platanensis, Gray, Ann. & Mag. Nat. Hist. 1873, xi. p. 302.

Nuchal scute transversely broad (in the adult about thrice as wide as long), but separated from the first costal by the produced anterior corners of the first vertebral. Vertebral and costal scutes with tuberosities which disappear with age, with the exception of those of the last two vertebrals and costals.

This is a large species, which was first noticed in this Journal (*l. c.*), the shell of a fully adult specimen being 9½ inches long. It inhabits the Rio de la Plata and fresh waters further to the south. The young differs so remarkably from the adult that I append a detailed description; it is figured on Pl. XIV.

This singular turtle reminds us at the first glance of the

Matamata, and in other respects of the *Platemys tuberosa* from British Guiana, which, however, is sufficiently distinct to be placed in the genus *Platemys*, as proposed by Peters. The shell is depressed, with a short oval outline, the hind margin being very obtuse. Each vertebral scute is raised in the middle into a tubercular prominence, and each costal is likewise provided with a similar prominence on its areola. The tuberosities of the marginal scutes are in the form of oblique ridges which terminate in a prominence at the posterior corner of each scute. Tubercular ridges radiate also from the areolar part of each vertebral and costal scute, so that the whole surface of the shell presents an extremely uneven appearance, resembling that of a rough stone.

Although there are six scutes along the vertebral line, the first of which is very little smaller than the second, and does not enter the margin of the shell, this genus does not differ in this respect from other turtles. That first scute is evidently only a very large nuchal shield which has been excluded from the margin by the enlarged foremost pair of marginals. If this were not the case, the number of costals would be increased too, and we should then have five of them instead of four.

The sternum is flat, much longer than broad, truncated in front and deeply notched behind, the margin forming an angular edge along the bridge connecting the sternum with the upper shell. The bridge is rather narrow, formed only by part of the abdominal and pectoral scutes, which are suturally connected with the fifth, sixth, and seventh marginals, inguinal and axillary scutes being absent. The median gular is large and very long, separating not only the gulars proper, but also nearly the postgulars. Abdominal rather narrower than the pectoral and the postabdominal; caudals large, two thirds the size of the postabdominals.

Neck long, bending towards the right and covered with granular skin, some of the granules on the sides being pointed; head flat, long, with short snout and short pointed nose, covered with soft skin, in which, however, the division into a great number of small scutes is distinctly indicated. Tympanum not visible; eyes of moderate size, with round pupil, close together, and partly directed forward. The snout is scarcely longer than the eye; nostrils small, round, directed forward. Jaws weak and narrow, covered with a horny sheath, the cleft of the mouth extending as far back as the eye. A broad fold at the angle of the mouth permits the gape to be opened wide in a vertical direction, and the numerous external folds of the skin along the lower side of the throat show also clearly that the œsophagus is very distensible, and that this turtle feeds on larger animals (fish or frogs) than one might suppose from the slenderness of the neck.

The legs are covered with soft scutes, of which the majority are very small, only a few being enlarged and transverse along the inner and outer edges of the fore and hind limbs. Toes broadly webbed, and the forearm provided with a fringe of skin. Claws four in front and behind, sharp, and of moderate size.

Tail extremely short.

Shell horn-coloured above, yellowish below; head, neck, and legs of a sandy colour; a white band proceeds from the angle of the mouth towards and along the lower side of the neck; it is edged with brown above and below, and seems to cross the eye and the forehead. Throat mottled with brown.

	inch.	lin.
Length of carapace	3	..
Greatest width of carapace	2	6
Length of sternum	2	4
Greatest width of sternum	1	7
Length of head and neck	1	11
Length of head	..	11
Width of head	..	7
Length of eye	..	$1\frac{3}{4}$

The specimen was discovered by Lieut. Gairdner in fresh water south of the Rio de la Plata. It is evidently very young, the umbilical cicatrix being still visible. Like the Matamata this species seems to be of sluggish habits, as fungoid growth has made its appearance on the upper shell as well as on the sternum; also in other respects the habits of both are probably identical.

LIV.—*Note on some East-African Antelopes supposed to be new.* By Dr. A. Günther, F.R.S.

Col. the Hon. Wenman C. W. Coke kindly placed in my hands some years ago the skull of a Hartebeest (*Alcelaphus*) which he had killed on the east coast of Africa, on his way to the Mpwapwa Mountains. The horns differed so remarkably from those of the other species of this genus, that I considered it then to be the type of a probably new species; and this supposition has been confirmed by Mr. J. Thomson bringing a frontlet of the same type from his late expedition to Mount Kenia and Victoria Nyanza. The animal killed by Col. Coke was probably a female; he preserved with the skull the skin of the head, which shows that the upper parts were of a reddish-brown colour, gradually passing into a light greyish brown below. For this species I propose the name of *Alcelaphus Cokii.*

Alcelaphus Cokii.

The horns diverge from their root so much as to form a right angle with the longitudinal axis of the skull, their basal portion being almost in the same plane with the forehead; their distal half forms again a right angle with the proximal half, the points being directed straight backwards. The front part of the horns is strongly ribbed longitudinally between the annulations, which are rather close near the base, and more widely placed and prominent at the bend of the horn with which the animal butts. The annulations are more or less effaced on the posterior surface of the horns and disappear altogether above the upper bend.

Mr. Thomson's specimen was an adult buck, in which the horns are somewhat stouter and their bend is more decidedly directed forwards.

Measurements.

	Col. Coke's spec. inches.	Mr. Thomson's spec. inches.
Length of the skull	17	..
Entire length of horn, measured round the curvature..................	16	$16\frac{1}{2}$
Length of horizontal branch of horn	7	$7\frac{1}{2}$
Length of distal half of horn	$7\frac{1}{2}$	$8\frac{1}{2}$
Greatest circumference of horn	8	$9\frac{1}{2}$

Mr. Thomson has also brought from the same expedition two frontlets (male and female) of a gazelle, similar to *Gazella Grantii*, which, however, after full consideration and comparison with the specimens in the Natural History Museum, I must consider specifically distinct. Both specimens come from animals which are not only fully adult, but, to judge from the sutures of the preserved part of the skull, of somewhat advanced age. The horns start much in the same direction as in *Gazella Grantii*, showing, however, scarcely any divergence in the male, and but a slight one in the female; also their curvature is much less than in *Gazella Grantii*. The

b c a

Gazella Thomsonii: *a* ♀, *b* and *c* ♂.

annulations are strongly marked, not less so behind than in front of the horn, closely arranged and about twenty in number; only a short distal portion of the horn is smooth. The horns are compressed, without enlargement of the base of the bony core, and much less developed as regards thickness and length than in *Gazella Grantii*, as will be seen from the following measurements :—

	♂.	♀.
	inches.	inches.
Length of horn	13	13
Circumference of horn at the base	$4\frac{1}{2}$	$3\frac{1}{4}$

The question naturally arises whether the horns described are those of younger individuals of *Gazella Grantii*; but this must be answered in the negative, as the cranial portion which has been preserved, of the male as well as of the female, shows that the animals were much older than our specimens of *Gazella Grantii*, which are armed with horns of that large size described and figured by Sir Victor Brooke. Moreover it is not conceivable that fully matured horns like those obtained by Mr. Thomson should be further developed into a shape or size like that of Grant's antelope. Finally Mr. Thomson informs me that the specimens were on the whole smaller than *Gazella Grantii*, a statement which is confirmed by the less width of the interorbital portion of the cranium. It is also worthy of notice that the deep notch in the orbital margin of the frontal bone, which is commonly observed in the skull of gazelles and also in *Gazella Grantii*, is scarcely indicated in the present species, for which I propose the name of *Gazella Thomsonii*.

Peters figured in the 'Monatsberichte' of the Berlin Academy for 1879, p. 832, the skull of a male antelope not fully adult, which he considered to be *Gazella Grantii*, but which clearly belongs to a distinct species. It resembles somewhat *Gazella Thomsonii* in the slight degree in which the horns diverge from each other; but their annulated portion is almost straight, and the annuli themselves are much further apart, much fewer in number (about twelve), and lower towards the hinder part of the horn. The base of the bony core shows a bossy swelling, which is different from that of *Gazella Grantii*, and entirely absent in *Gazella Thomsonii*. This species may be called *Gazella Petersii*.

Mr. Thomson has kindly supplied me with some further particulars. His antelope is marked with a distinct, black lateral band, the absence of which is characteristic of *G. Grantii*. He found it in small herds, in country in which the latter was abundant, the herds of the two species never mingling with each other. He observed it over the range of country from Kilimanjaro to Baringo and at various heights under 6000 feet. According to our present knowledge, *Gazella Grantii* would seem to occur further north and south than the two other forms, it having been obtained by Capts. Speke and Grant and Mr. Arkwright in the Ugogo district, and by Sir J. Kirk in South Somali Land. The skull of *Gazella Petersii* was obtained at the mouth of the Dana river in northern Zanzibar, the collector stating that the species is very common in the Gallas Land.

LV.—*Description of a new Species of the Carabideous Genus* Callistomimus. By CHARLES O. WATERHOUSE.

Callistomimus Dicksoni, n. sp.

Head bluish green, smooth in the middle, strongly punctured at the sides. Antennæ nearly black, the first, second, and base of the third joints pitchy. Thorax yellowish red, strongly and rather closely punctured, the median line deeply impressed. Elytra dark olive-green, almost black, the base and margins paler olive-green; the suture with a yellowish-red stripe reaching to the apex. Each elytron with two transverse pale yellow spots—the first near the base, reaching from the sutural stripe to near the margin; the second about one quarter from the apex, slightly arched, not quite touching the lateral margin. Legs pale testaceous; the knees, the apex of the tibiæ, and the apex of the tarsi blackish. Body beneath black.

Length $5\frac{3}{4}$ millim.

Hab. Formosa (*M. Dickson, Esq.*).

This species is relatively longer and narrower than *C. modestus*, Schaum, and quite differently coloured. The thorax is very similar in form, but is a little less constricted at the base; the disk is more convex and the medial line more impressed. The elytra resemble those of *Callistus lunatus* in general form, but are narrower.

LVI.—*Description of a new Species of* Julodis (*Coleoptera, Buprestidæ*). By CHARLES O. WATERHOUSE.

Julodis Finchi, n. sp.

Castanea, pube sordide alba induta; thorace medio impresso, lineis guttisque numerosis nitidis ornato; elytris tomentosis, lineis quatuor interruptis parum elevatis rugisque numerosis nitidis calvis. Long. 31 lin. (67 millim.).

Uniform brown, with all the surface (except where there are elevations) densely clothed with sandy-white pubescence. Thorax convex, with an irregular longitudinal median impression, on each side of which is a sinuous, raised, smooth line, which branches in front; there are also several smooth raised spots and marks on the disk, and on the sides numerous small round spots. Elytra rugulose, the raised rugæ smooth and shining, the interstices filled with whitish pubescence, but the pubescence does not form any distinct pattern.

Hab. Karachi.

This fine species is about twice the size of the largest of those hitherto described. It appears to be most nearly allied to *J. Whithillii.*

The specimen was sent to the British Museum by the Secretary of the Zoological Society, who received it from Mr. B. Finch with the above-given locality.

BIBLIOGRAPHICAL NOTICES.

Journal and Proceedings of the Royal Society of New South Wales for 1883. Vol. XVII. Edited by Prof. A. Liversidge, F.R.S. 8vo. Sydney, 1884.

Anthropology is represented in this issue by an interesting article on the aborigines inhabiting the great lacustrine and riverine system of rivers and creeks which the Lower Murray takes from Moama to Wentworth, including the Lower Murrumbidgee, Lower Lachlan, and Lower Darling. Seven tribes are here treated of as to characters, features, language, habits, &c. by Peter Beveridge. Astronomy gives us a list of 130 new double stars prepared by H. C. Russell, the Government Astronomer. Hydrology comprises a paper on irrigation in New South Wales by H. C. Russell, who supplies also meteorological observations and a rainfall map; another on water-supply and irrigation in that colony, by A. P. Wood; and on irrigation in Upper India, by H. G. McKinney.

The botanists give the following:—on plants used by the natives of North Queensland, Flinders, and Mitchell Rivers, for food and medicine, by E. Palmer; on Macrozamia, by C. Moore; on the roots of the sugar-cane (with two plates), by H. L. Roth; and additions to the list of genera of plants indigenous to Australia, by F. von Müller. The chemistry of Australian products, as collected in abstracts down to 1882, is prepared by W. A. Dixon. A note, by E. H. Rennie, on the discoloration of white bricks made from certain clays in the neighbourhood of Sydney, also refers to chemical investigations.

There are two geological communications. The first is by J. E. Tenison-Woods, on a series of strata hitherto known as the Waianamatta Shales, and supposed to lie above the Hawkesbury Sandstone.

He criticizes the views of former observers, and argues that the shales in question do not lie on the top of the sandstone, but are intercalated with it; that fossil plants of the same genera and species are found in both the shale and the sandstone; and that the former have originated in thick vegetable growths on a land-surface, with or without shallow marshes. The second geological paper is by R. Etheridge, Jun., on Australian *Strophalosiæ* (Palæozoic), and on a new *Aucella* (*Auc. Liversidgei* vel *hughendensis*) from the Cretaceous rocks of N.E. Australia, noticing also *Inoceramus marathonensis* and another, and *Ancyloceras Flindersi*, and another from the same rocks; two plates illustrate this paper.

The Presidential Address, by Chr. Rolleston, rich with a cordial and philosophical notice of Darwin, his works and views, is not the least interesting of the several good papers in this volume.

Internationale Zeitschrift für allgemeine Sprachwissenschaft. Edited by F. Techmer. Bd. i. Hft. i. Leipzig, 1884.

We have received the first instalment of the new journal of comparative philology, edited by Herr Techmer, with the assistance of a very distinguished company, among which we see the names of Professors Lepsius, Max Müller, Oppert, Potl, Sayce, and Wundt. With such a staff a journal ought to find a wide area of circulation.

The essay which will most interest the readers of the 'Annals' is that by F. Techmer, which deals with the scientific analysis and synthesis of audible language. The earlier portion deals with synthesis from the point of view of the physicist, the latter with the anatomical analysis. The student of works in English will remember that a study of this kind was made by Prof. Max Müller in the second series of his well-known lectures on the Science of Language, wherein one was devoted to the "Physiological Alphabet." Having the two contributions before us as we write, we have to say that the latter essay affords us an excellent example of the great improvements brought about in the last fifteen years in the illustrations of anatomical and physical points.

It is true, indeed, that Merkel's work, from which many of Techmer's figures are taken, was published before Prof. Max Müller's lectures; but this point is really for, and not against, our view, inasmuch as had the standard of illustration been as high in 1870 as it is in 1884 the popular lecturer would have been as well advised as the scientific essayist, and have gone like him to an admirable source of representation.

It would not be right to compare the methods of a lecture delivered before a more or less general audience and the close investigation which is suited to the pages of a journal for specialists.

There is a particularly interesting essay by Mr. G. Mallery on Sign-Language—a subject which has not escaped the American Bureau of Ethnology. It is a mistake to suppose that an Indian cannot rise to the necessities of the situation and invent, when needful, new signs. An instructive proof of this is afforded by Mr.

Mallery, who requested an Indian to make the sign for a steamboat —an object seen for the first time a few days before. "After thinking a moment he gave an original sign, described as follows:— Make the sign for water by placing the flat right hand before the face, pointing upward and forward, the back forward, with the wrist as high as the nose; then draw it down and inward toward the chin; then with both hands indicate the outlines of a horizontal oval figure from before the body back to near the chest (being the outline of the deck); then place both flat hands, pointing forward, thumbs higher than the outer edges, and push them forward to arm's length (illustrating the powerful forward motion of the vessel)."

The indications given by a notice of these two papers will show that an important addition has been made to the number of scientific journals. Into the purely philological papers it would be improper for us to enter here.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.

June 25, 1884.—Prof. T. G. Bonney, D.Sc., F.R.S., President, in the Chair.

The following communications were read:—

1. "On some Fossil Calcisponges from the Well-boring at Richmond, Surrey." By Dr. G. J. Hinde, F.G.S.

Numerous specimens of diminutive sponges were met with in a band of calcareous shale in the Richmond well-boring, at a depth of 1205 feet beneath the surface. They proved to be all Calcisponges belonging to Zittel's family of Pharetrones. Five species, all new, were described, and referred to the genera *Inobolia*, *Peronella*, *Blastinia*, and *Oculospongia*. The spicular structure of the fibres can be seen in microscopic sections of the different species, and in some examples even the spicules of the dermal layer are preserved. From the general facies of the specimens, and the fact that one species is closely allied to *Blastinia costata*, Goldf., from Lower Jurassic strata at Streitberg, the author thought it probable that the stratum in which the sponges occur is of Lower Jurassic age.

2. "On the Foraminifera and Ostracoda from the deep Boring at Richmond." By Prof. T. Rupert Jones, F.R.S., F.G.S.

From some strata at three special depths (§ i. 1145′ 9″ to 1146′ 6″; § ii. 1151′ to 1151′ 6″; and § iii. 1205′) in the deep boring at Richmond, several Foraminifera and Ostracoda have been obtained by Prof. Judd, but they do not present any very special characteristics recognizable as belonging to particular horizons. The Foraminifera comprise several common forms or varieties of *Cristellaria*, *C. rotulata* occurring at each of the depths alluded to. Specimens of the Nodosarinæ occur very rarely in the lowest stratum of the three; also *Spirillina*, *Pulvinulina* (of the *elegans* type), several small individuals of *Planorbulina Haidingeri*, and vars., and one small *Miliola*.

Of the Ostracoda there are several forms not previously published; and, for the most part, they differ in the three stages alluded to; but one *Cythere* occurs in § i., § ii., and § iii.; one in § i. and § iii.; and a *Cytherella* in § ii. and § iii.

Excepting a general Upper Mesozoic aspect, these limited groups offer no special characteristic so far as yet examined.

3. "Polyzoa (Bryozoa) found in the Boring at Richmond, Surrey, referred to by Prof. J. W. Judd, F.R.S." By G. R. Vine, Esq. Communicated by Prof. Judd, F.R.S., Sec. G.S.

The Bryozoa from the Richmond well, which are in an admirable state of preservation, include no less than 14 different forms, most of which are characteristic of the Great Oolite of this country and the continent. Two or three forms, however, are new, and detailed descriptions were given of them in the present paper. Six of the forms found at Richmond occur also among the fossils collected by the late Mr. C. Moore from the oolitic rock met with in the boring at Messrs. Meux's Brewery.

4. "On a new Species of *Conoceras* from the Llanvirn Beds, Abereiddy, Pembrokeshire." By T. Roberts, B.A., F.G.S., Woodwardian Museum, Cambridge.

This new species of *Conoceras* was obtained by the author from a new quarry about half a mile to the north-west of the Llanvirn quarry, Abereiddy.

The fossil consists in great part of a mould of the shell, together with a much compressed, obliquely cut, longitudinal section of the shell itself, which can be removed from its mould. On the posterior part of the fossil the course of the sutures of the septa can be fairly well seen: after passing upwards for a short distance, the sutures bend forward, and, meeting those from the opposite side, which are similarly bent, form a band of superposed chevrons, situated mesially in this part of the fossil. When the shell is removed from its mould the chevron band appears to be distorted, and is then continued forward as a narrow, partly disconnected groove, to the anterior margin of the fossil. There is a ridge on the shell itself corresponding to this groove, which the author considers to be the siphuncle.

On the anterior part of the fossil coarse corrugations are present which correspond to the lines of growth of the shell. The body-chamber is not preserved.

Only 5 species of *Conoceras* have as yet been described; the author compared the Llanvirn species with these, and also with a fossil from the Devonian of Nassau, which Kayser referred to *Gomphoceras*, but which possesses several characters in common with *Conoceras*.

The horizon from which this new species was obtained is that of the Llanvirn Beds, some typical Llanvirn fossils having been found with it. The author named the species *Conoceras llanvirnensis.*

5. "Fossil Cyclostomatous Bryozoa from Australia." By A. W. Waters, Esq., F.G.S.

In the present paper the Cyclostomata from Curdies Creek, Mount Gambier, Bairnsdale, Muddy Creek, &c., Aldinga and River-Murray Cliffs were described, bringing the total number of fossil Bryozoa from Australia, dealt with in this series of papers, up to 195, of which 85 are known living. Of the 32 Cyclostomata now dealt with, 12 at least are known living, and one cannot be distinguished from a Palæozoic form; 9 are apparently identical with European Cretaceous fossils.

Although so many remind us of European Chalk and Miocene species, great stress was laid upon the imperfect data available for such comparisons, the Cyclostomata furnishing but few characters which are available for classification, which, so far, has almost entirely been based upon the mode of growth, which, in the Chilostomata, has been shown to be of secondary value. In consequence of the few available characters the Cyclostomata do not seem likely to be ever so useful palæontologically as the Chilostomata, and as they are less highly differentiated, it is not surprising to find that they are more persistent through various periods.

In order to see how far other characters might be available, the author has examined Cyclostomata, both recent and fossil, from many localities and strata, and pointed out that the size of the zoœcia should always be noticed, as also the position of the closure of this tube. The arrangement of the interzoœcial pores may frequently give great assistance, and these are considered the equivalents of the rosette-plates; but the most useful character of all is no doubt the ovicell, which varies specifically in position and structure; but this unfortunately occurs on but few specimens, and has rarely been described fossil, although greater attention to this will no doubt lead to its being frequently found and noticed.

6. "A Critical and Descriptive List of the Oolitic Madreporaria of the Boulonnais." By R. F. Tomes, Esq., F.G.S.

The author commenced with some general remarks upon certain Oolitic genera of Corals, especially *Bathycœnia*, *Cyathophora*, and *Depaphyllum*. He stated that his observations upon the Corals of the Great Oolite of the Boulonnais confirm the conclusions as to the palæontological uniformity of that formation based by Dr. Lycett chiefly on the study of the Mollusca. In the Boulogne district the Great Oolite rests immediately upon Palæozoic rocks, and there are no traces of any Corals of Inferior-Oolite type. Those met with near the bottom of the Great Oolite seem to approach those of the English Cornbrash. After a tabular sketch of the different beds of Oolitic age in the Boulonnais, the author gave a list of the species as follows:—

From the Great Oolite:—*Discocœnia bononiensis*, g. & sp. n.;

Ceratocœnia elongata, g. & sp. n.; *Scyphocœnia staminifera* and *excelsa*, g. & sp. n.; *Bathycœnia hemisphærica*, sp. n.; *Convexastræa Waltoni*, E. & H.; *Cryptocœnia obeliscus*, Mich.; *C. plana*, sp. n.; *C. Rigauxi*, sp. n.; *C. microphylla*, Tomes; *Stylina*, sp.; *Montlivaltia caryophyllata*, Lamx.; *M. Rigauxi*, sp. n.; *Cladophyllia Babeana*, E. & H.; *Septastræa rigida*, sp. n.; *Confusastræa Rigauxi*, sp. n.; *C. magnifica*, Tomes; *Confusastræa*, sp.; *Isastræa limitata*, Lamx.; *I. explanata*, Goldf.; *I. tuberosa*, sp. n.; *Latimæandra*, sp.; *L. lotharinga*, From.; *Thamnastræa mammosa*, E. & H.; *Anabacia complanata*, Defr.; *A. Bouchardi*, E. & H.; *Genabacia stellifera*, E. & H.; and *Microsolena excelsa*, E. & H. From the Coral Rag: *Stylina*, 2 sp.; *Calamophyllia pseudostylina*, Mich.; *Rhabdophyllia Phillipsi*, E. & H.; *Thecosmilia annularis*, E. & H.; *Confusastræa*, sp.; *Dimorphophyllia jurensis*, Beck.; *Latimæandra sequana*, From.; *Isastræa explanata*, Goldf.; *I. helianthoides*, Goldf.; *I. portlandica*, From.; *Trochoseris oolitica*, sp. n.; *Thamnastræa ? latimæandroidea*, sp. n.; *T. ? concinna*, Goldf.; *T. foliacea*, Quenst.; *T. gibbosa*, Beck.; *Microsolena expansa*, Etall.; and *Comoseris irradians*, E. & H.

7. "On the Structure and Affinities of the family Receptaculitidæ, including therein the genera *Ischadites*, Murch. (= *Tetragonis*, Eichw.), *Sphærospongia*, Pengelly, *Acanthochonia*, g. n., and *Receptaculites*, Defr." By Dr. G. J. Hinde, F.G.S.

The author's observations have been derived from the study of numerous examples of the family from Silurian and Devonian strata in Devonshire, the west of England, Belgium, Silesia, Bohemia, the isle of Gotland, Canada, and the United States. In an historical sketch the author showed that the members of this group have been at various times referred to pine-cones, Foraminifera, sponges, corals, cystideans, and tunicate Mollusca, and that the latest authorities who have written on them consider their systematic position as altogether doubtful.

The present mineral constitution of these fossils is either of crystalline calcite, silica in a secondary condition, iron peroxide, or iron pyrites, or they occur as empty moulds, and from the similarity to the present mineral condition of undoubted siliceous sponges, the author thinks that the Receptaculitidæ were also originally siliceous. The skeleton of the members of the group consists of modified hexactinellid spicules, in which the summit-ray of the spicule is changed into a rhomboidal or hexagonal plate with the four horizontal rays or arms immediately beneath it, whilst the vertical ray or shaft tapers to a point, and terminates freely in *Ischadites* and *Acanthochonia*; in *Sphærospongia* it is partially absorbed; and in *Receptaculites* it develops a plate at its distal extremity. The spicular rays are traversed by axial canals, as in other hexactinellid spicules, and these unite in the central point of junction of the rays. The spicules are definitely arranged so that their summit-plates form regularly oblique rows crossing each other, and the horizontal rays radiating and transverse rows.

The genus *Ischadites* consists of conical or ovate bodies enclosing a central cloacal cavity with a summit-aperture. The basal nucleus or commencement of growth consists of eight small spicules arranged in a circle; the spicule-plates are rhomboidal; there is no inner plate, as in *Receptaculites.* The genus *Tetragonis*, Eichw., is undoubtedly congeneric with *Ischadites*, and, being of later date, becomes obsolete. *Acanthochonia*, g. n., resembles *Ischadites* in spicular structure, but it is open cup-shaped; it is formed to include a single species, named *A. Barrandei*, from Bubowitz, in Bohemia. The genus *Sphærospongia*, Pengelly (pars Salter), has hexagonal summit-plates, and the vertical spicular rays are only partially developed. The genus *Receptaculites* is cup-shaped; the spicular plates are rhomboidal, and the vertical rays develop at their extremities definite plates, which apparently amalgamate into a continuous perforated layer. The author concluded that the Receptaculitidæ constitute a distinct family of siliceous hexactinellid sponges, whose nearest relationships are to *Protospongia*, *Dictyophyton*, and *Plectoderma*.

The genera *Cyclocrinus*, Eichw. (=*Nidulites*, Salter), *Pasceolus*, Billings, and *Archæocyathus*, Bill., though ranged with the Receptaculitidæ by some authors, were shown to have no structural relationship to that family.

8. "On the Pliocene Mammalian Fauna of the Val d'Arno." By Dr. C. J. Forsyth Major. Communicated by Prof. W. Boyd Dawkins, F.R.S., F.G.S.

A list of the fossil Mammalia was given, containing the names of thirty-nine species known to the author. This list contains no species common to the older fauna on the limit between Miocene and Pliocene, a fauna characterized by the presence of *Hipparion* and met with at Pikermi, Eppelsheim, and other places. The Montpellier fauna contains an admixture of older and newer types; but it is not clear that this admixture has not taken place after extraction. Some Val d'Arno types extend to the Sewaliks of Northern India, for *Equus Stenonis* and *Sus Strozzii* of the former are probably the same as *E. sivalensis* and *Sus giganteus* of the latter.

It has been asserted that the marine Pliocene of Italy is older than the lacustrine strata of the Arno valley. This, however, is not the case; some of the mammalian species found in the latter occur also in shore-deposits belonging to the first named.

The Pleistocene fauna in Italy appears to be quite distinct specifically from the Pliocene. Portions of both, however (often designated the African division), appear to be closely allied. This is especially the case with certain forms of *Hyæna*, *Felis*, *Rhinoceros*, and *Hippopotamus*. Some of the differences between species of the two last-named genera were discussed.

The relations of the Arno-valley fauna to living Mammalia were next considered, and it was shown that although some genera, as *Hippopotamus*, are only met with living in the Ethiopian region, a much larger number of forms, such as *Tapirus* and several bovine and cervine species, are now represented in south-eastern Asia and the Sunda islands. The occurrence of these animals in tropical countries at the present day does not, however, necessarily imply a tropical climate in Pliocene Italy. Some instances in modern geographical distribution are quoted in illustration of this opinion. It is probable that the Pliocene fauna of Europe extended as far as Celebes, and has been preserved in the Indian archipelago by isolation.

In conclusion it was shown that the preservation of a Miocene form, *Myolagus sardonis*, in the Pleistocene bone-breccias of Corsica and Sardinia, and the occurrence of *Elephas meridionalis* and *Mastodon arvernensis* in beds of different age on opposite sides of the Alps, are instances in support of the view that a single mammalian species or even a few species cannot be sufficient to determine the age of beds.

In a note appended to the paper, Prof. Boyd Dawkins contested the opinion that no species pass from Miocene to Pleistocene beds, especially in the case of *Hippopotamus major* of the former and *H. amphibius* of the latter.

9. "Notes on some Cretaceous Lichenoporidæ." By G. R. Vine, Esq. Communicated by Prof. P. Martin Duncan, F.R.S., F.G.S.

In this paper the author referred to the views of Mr. Hincks on the genera belonging to the family Lichenoporidæ, and especially to his suppression of the genus *Radiopora* of D'Orbigny, the species of which are placed by Mr. Hincks in the genus *Lichenopora*. The author remarked that the type species of the division of the latter genus identified by Mr. Hincks with *Radiopora*, D'Orb., the Lower Greensand *Radiopora pustulosa*, D'Orb., and other fossil species show structural peculiarities which would seem to distinguish them, although perhaps not generically. He described in some detail the characters of the above-mentioned species under the name of *Lichenopora pustulosa*; and further described what he believed to be a new species from the Greensand of an unknown locality under that of *Lichenopora paucipora*.

MISCELLANEOUS.

On Paludicella erecta.

Mr. Edward Potts desired to have a preliminary record made of his recent discovery or identification of a new species of *Paludicella* for which he proposes the name of *Paludicella erecta*.

This genus of freshwater Polyzoa has heretofore contained only the single clearly defined species *P. Ehrenbergi*, Van Beneden (*Alcyonella articulata*, Ehrenberg), the other two names, *P. procumbens* and *P. elongata*, suggested by Mr. Albany Hancock and Prof. Leidy, being considered by Prof. Allman as identical with the original type. The present form is strikingly different from the old one, both in the number of its ciliated tentacles and in the character of the cœnœcial cells. The doubt which has lingered in the mind of the speaker has not been as to the species, but whether in view of the difficult determination of the characteristic septa between the cells, amounting, in fact, to an apparent absence of them, a new genus might not be required to accommodate it.

It was first noticed in Tacony Creek, a small stream in Montgomery County, Pennsylvania, at that place perhaps 50 feet above tide-water. A few days after it was also gathered within tidal limits in both the Delaware and Schuylkill rivers, near Philadelphia. In the first-named locality it was found most abundantly in the pools amongst the rapids of the stream, frequently covering the upper surface of stones, at the depth of a foot or more, to the extent of many square inches. The erect portions of the cœnœcial cells in the denser parts of the colonies are about a line in height, and, standing very closely, suggest a comparison with the surface of a chestnut-burr. In the rivers they were found penetrating the mass of incrusting sponges, particularly *Meyenia Leidyi.*

These upright tubules are chitinous prolongations of very irregularly inflated cells, resting in compact disorder upon the supporting surface, crossed and connected in some manner not yet intelligible, by meandering cylindrical rhizomes, sometimes of great relative length. These are mostly terminal and simple, but are sometimes branched, and frequently originate in an indifferent lateral portion of a cell. The tubular prolongations are, of course, always single; the invaginated polyp retiring within the inflated portion of the cell. Septa were, in a few instances, discovered in the rhizomes near their insertion or connection with the inflated portion of the cells. The upright portion of those cells which seemed to be least matured were longer than those of their older neighbours, subclavate or spindle-shaped and rounded at the extremities. The others are cylindrical or slightly widening downwards, and shorter than the former by the invagination of the terminal portion of the ectocyst. This has the effect of producing the angular appearance of the orifice so familiar in the older species; but while that is generally quadrangular, this has frequently five or more sides. The younger cells are nearly transparent, but they darken with age and become somewhat incrusted with adherent particles and overgrown by commensal parasites, *Limnias, Pyxicola,* and the like.

The polypides are shy, but fond of the light, and when otherwise undisturbed will remain for a long time protruded in the full glare of microscopic illumination. It can then be seen that the lophophore is circular, without epistome, supporting ordinarily twenty tentacles, taking the shape of a claret-glass and opening upwards. (Nineteen and twenty-one tentacles have been doubtfully counted, while the above-mentioned number is frequent; *P. Ehrenbergi* is universally stated to have but sixteen.) A peculiarity of the tentacles is the presence upon the outer median line of each, of a rather sparsely filled series of quiescent setæ, in strong contrast with the rapidly moving cilia around them.

The development of this polyp from the ovum, of which interesting hints have been obtained, and its internal structural peculiarities are reserved for further study, and if satisfactory results shall have been attained, they will be treated of in a later paper. The nearly simultaneous observation of this species in three distinct localities, and its abundance in each, indicates that it is probably not uncommon, and excites surprise that it does not appear to have been previously noticed.—*Proc. Acad. Nat. Sci. Philad.*, Aug. 5, 1884, p. 213.

On a new Insect of the Genus Phylloxera (Phylloxera salicis, *Licht.*). By M. J. Lichtenstein.

I had for some time observed the presence, upon the bark of willows in my garden, of a sort of snow-white mould, like the cottony secretions of many Coccidina. By splitting a piece of bark I discovered a dried-up skin, which I softened in caustic potash, and which, under the microscope, showed the form of a *Phylloxera*. It is an insect 0·67 millim. long, with antennæ of three joints and a very long rostrum, reaching considerably beyond the abdomen.

By examining the bark I succeeded in finding in the same fissure some small ovoid envelopes of two different dimensions, some being 0·36 and others 0·25 millim., nearly colourless and looking like eggs. It was evident to me that I had not to do with true eggs, but with what I have called *sexual pupæ*. I then placed these little envelopes in a tube and examined them daily.

I first saw these little pupæ raise themselves upon the posterior extremity and begin to grow, escaping from a very fine pellicle, which, as it were, formed a stalk for them. About the fourth or fifth day I began to distinguish two little black eyes; then small and excessively short feet, and antennæ, still shorter, forming only a little three-jointed stump. For eight or ten days I was able to follow the development of this microscopic germ, balancing itself in its silky calyx and constantly rising.

Finally the evolution was completed, and, like ripe seeds, the sexual insects, male and female, dropped on to the cork of the little tube containing them, and copulation took place. The male dies soon afterwards. The female then deposits an enormous light yellow egg, nearly as large as herself, and I submitted the two sexes to the microscope.

As I had foreseen, these were really sexual insects, presenting all the characters of the *Phylloxeræ*. The rostrum is completely deficient, the limbs are nearly rudimentary, especially the antennæ, which are reduced to a very short knob.

The *mould* upon the willow is nothing but an accumulation of the cast envelopes of these pupæ, which escape in so singular a fashion from their long pellicle.

I do not know that I shall succeed in tracing the further evolution of this insect, but I can not understand, considering its abundance, how it has hitherto escaped observation. I shall call it *Phylloxera salicis*. It will fall within the group of those in which he *pupiferous* form is apterous. I shall endeavour in the spring to omplete its history.—*Comptes Rendus*, October 13, 1884, p. 616.

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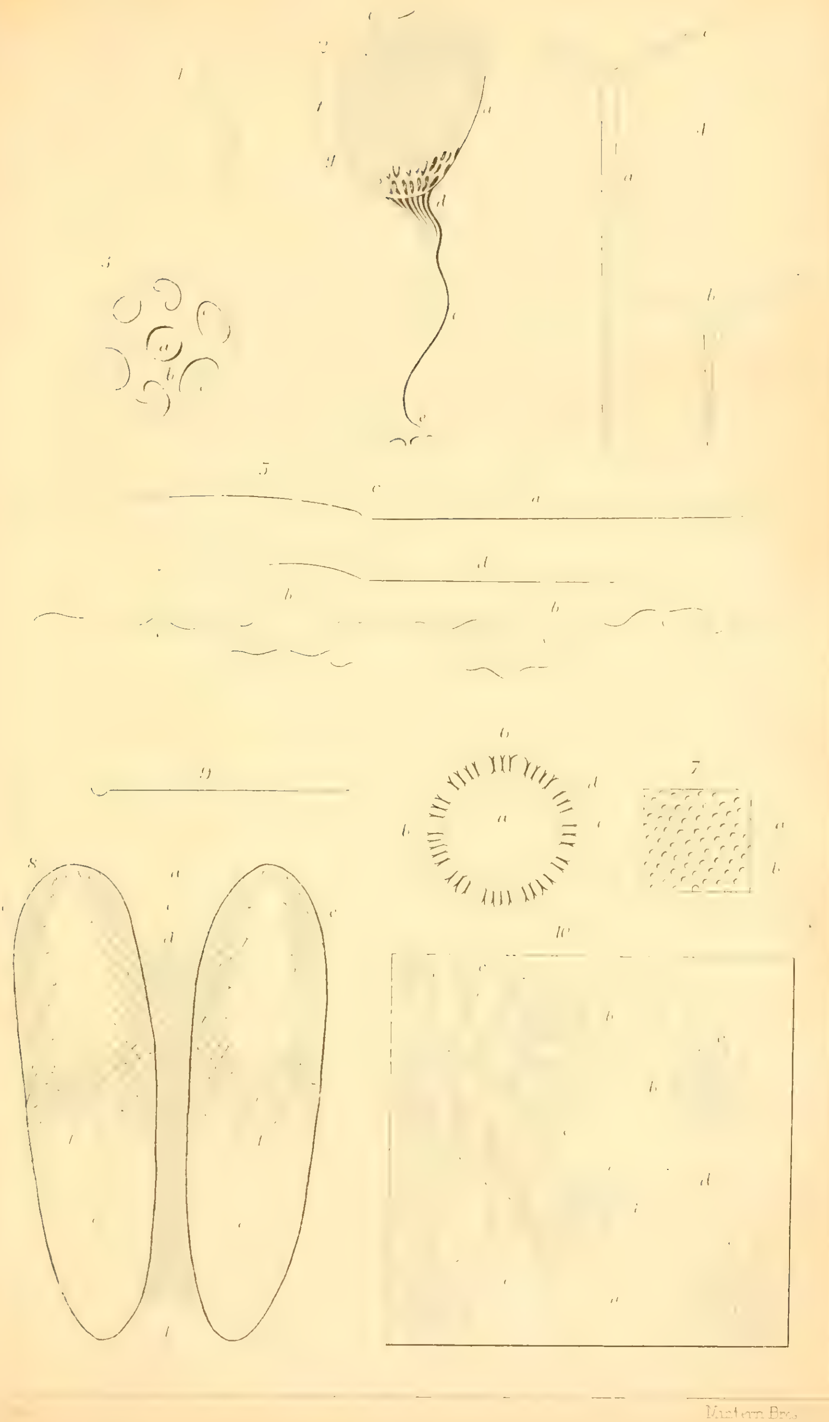

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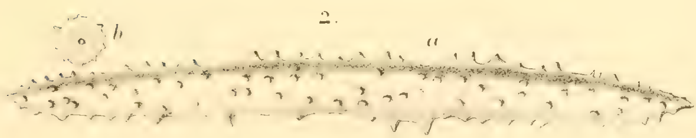

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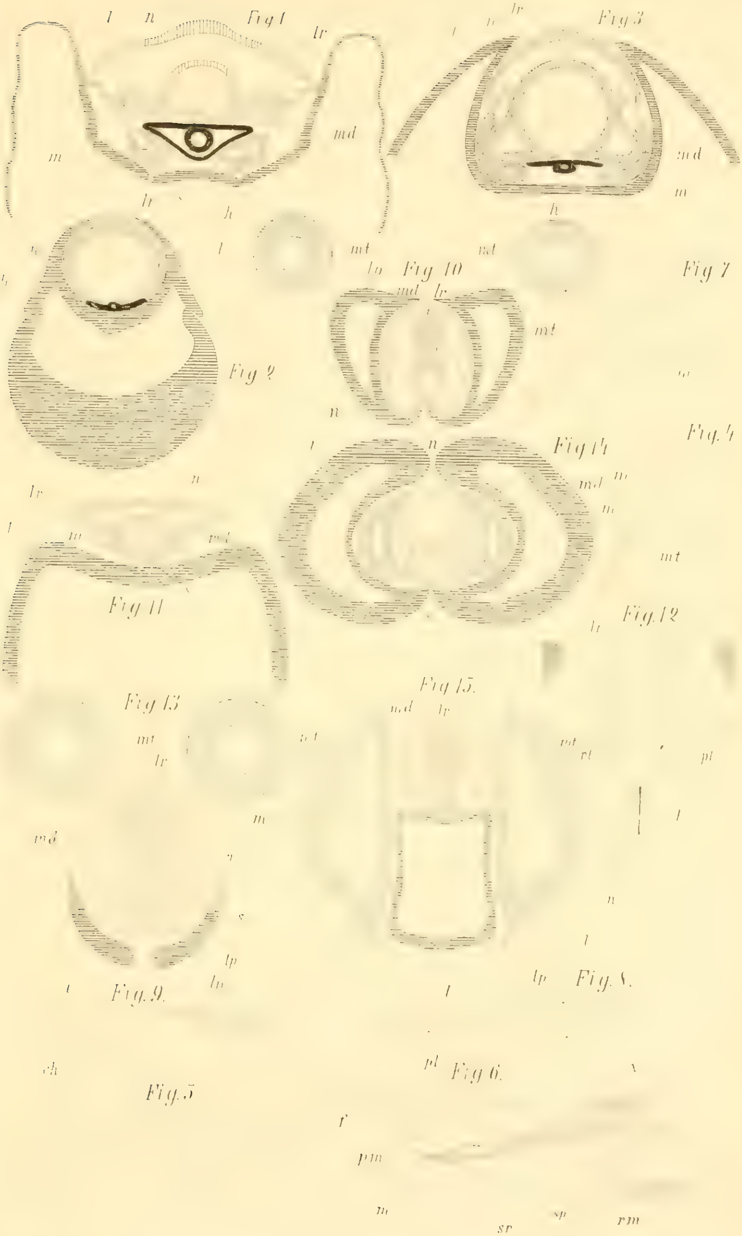

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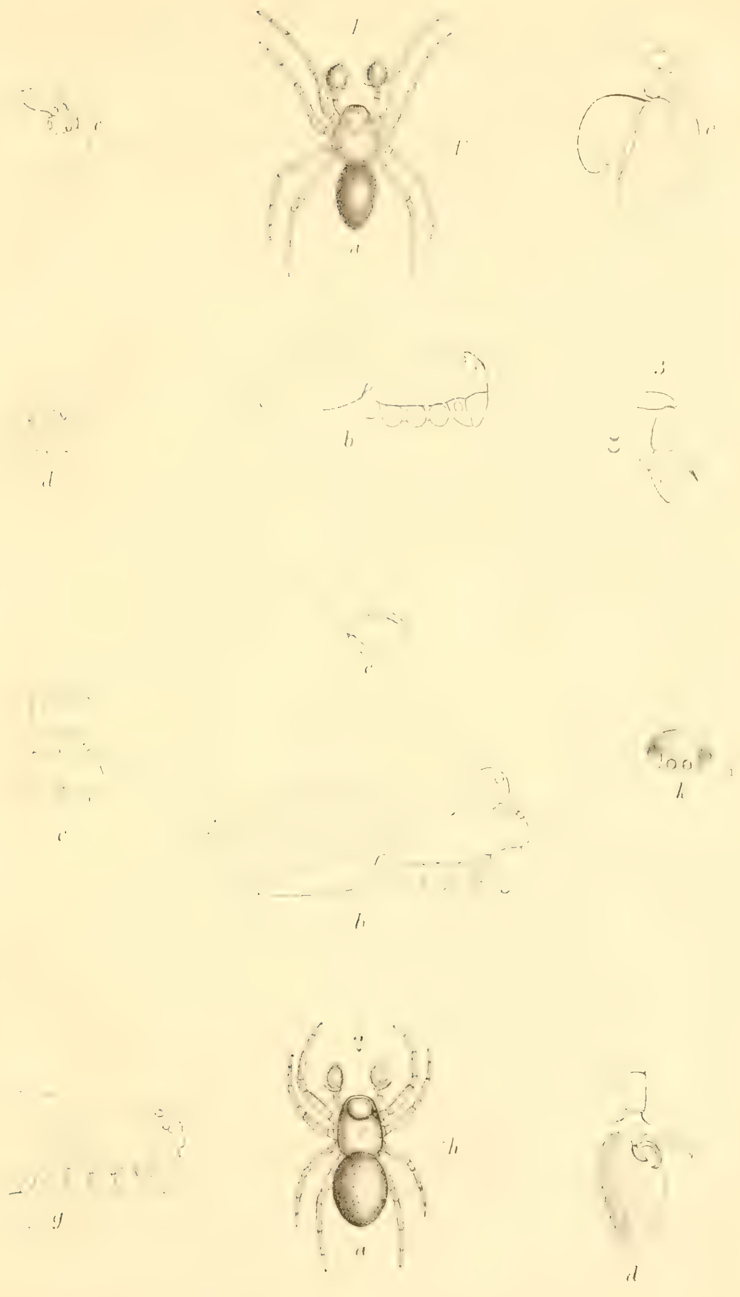

New Species of Walckenaera Bl.

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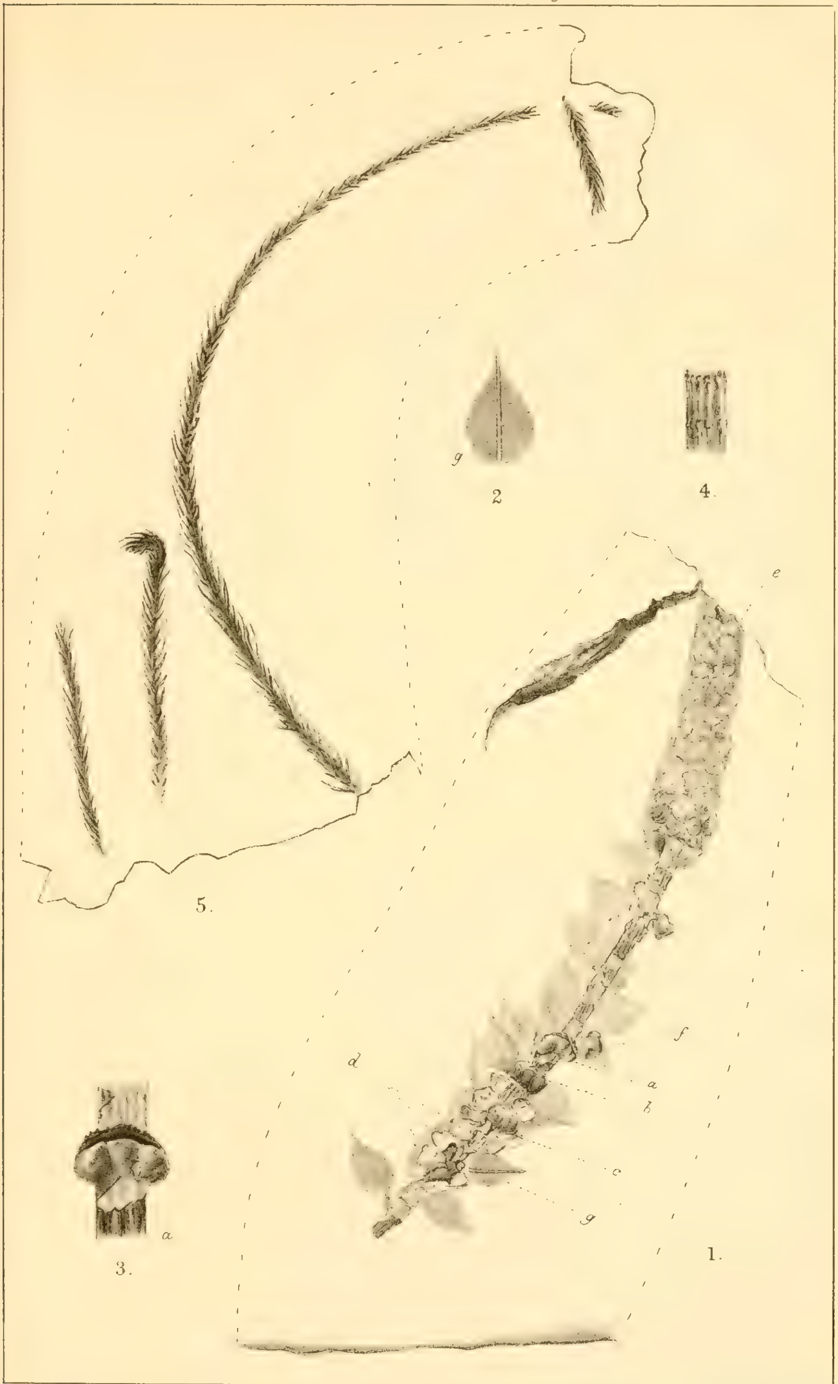
E. Carter lith.

Mintern Bros imp



R. Kidston, del.

McFarlane & Erskine, Lith.rs Edin.r

1–4. LYCOPODITES STOCKII. *Kidston. n.s.*
5. LEPIDODENDRON RIMOSUM. *Sternberg.*

Ann. & Mag. Nat. Hist. S. 5. Vol. 14. Pl. VI.

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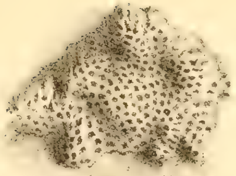

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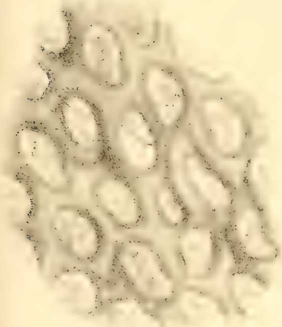

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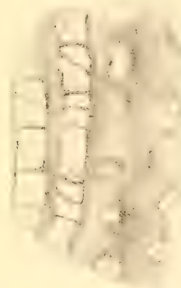

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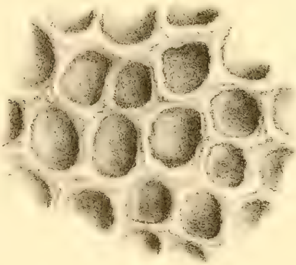

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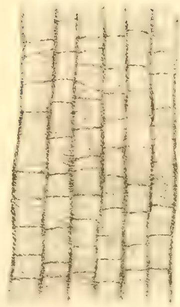

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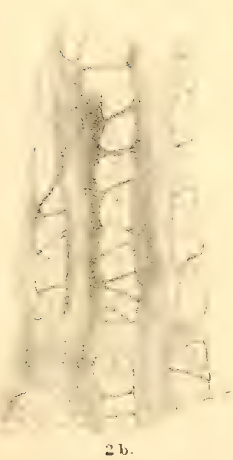

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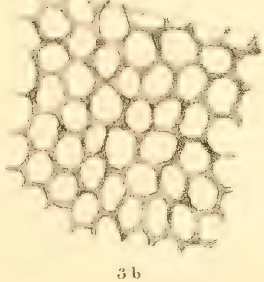

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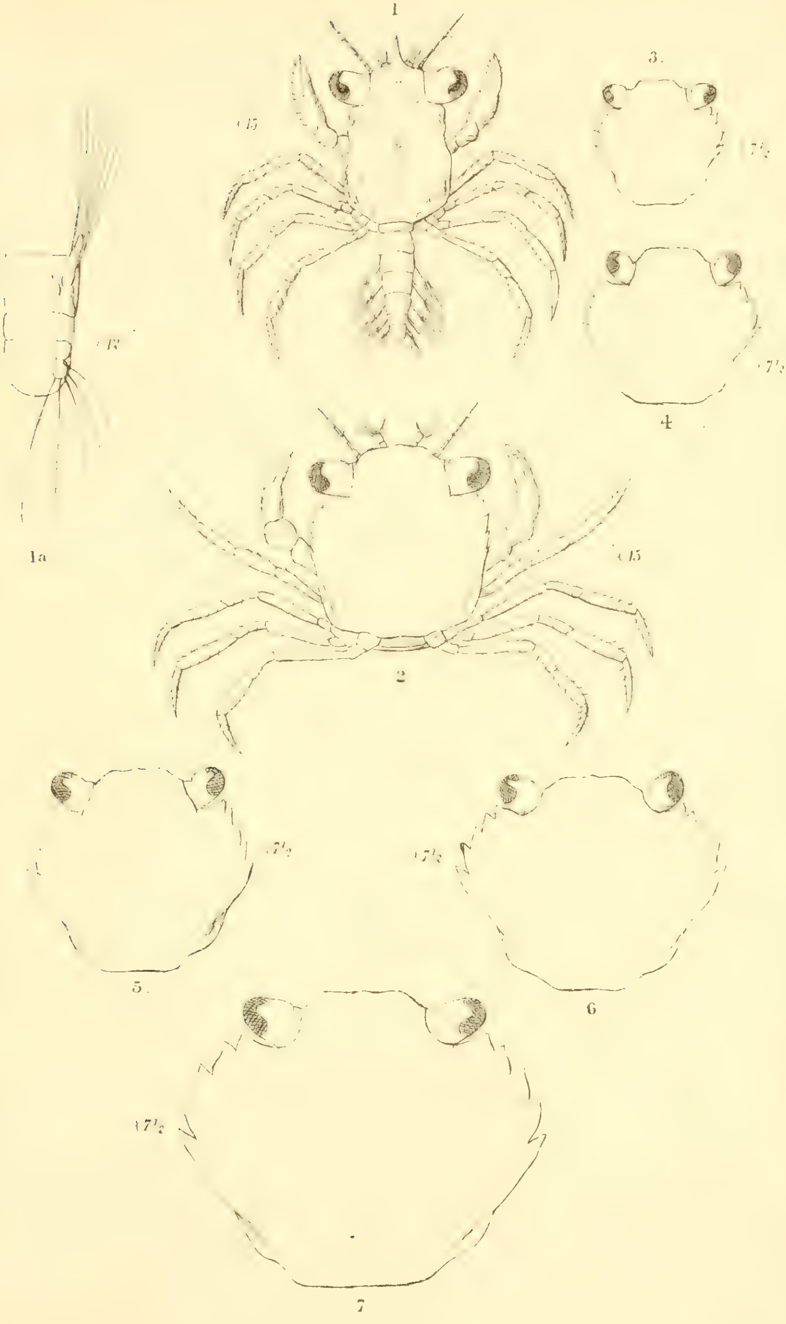
A. S. Foord del. et lith.

Mintern Bros. imp.



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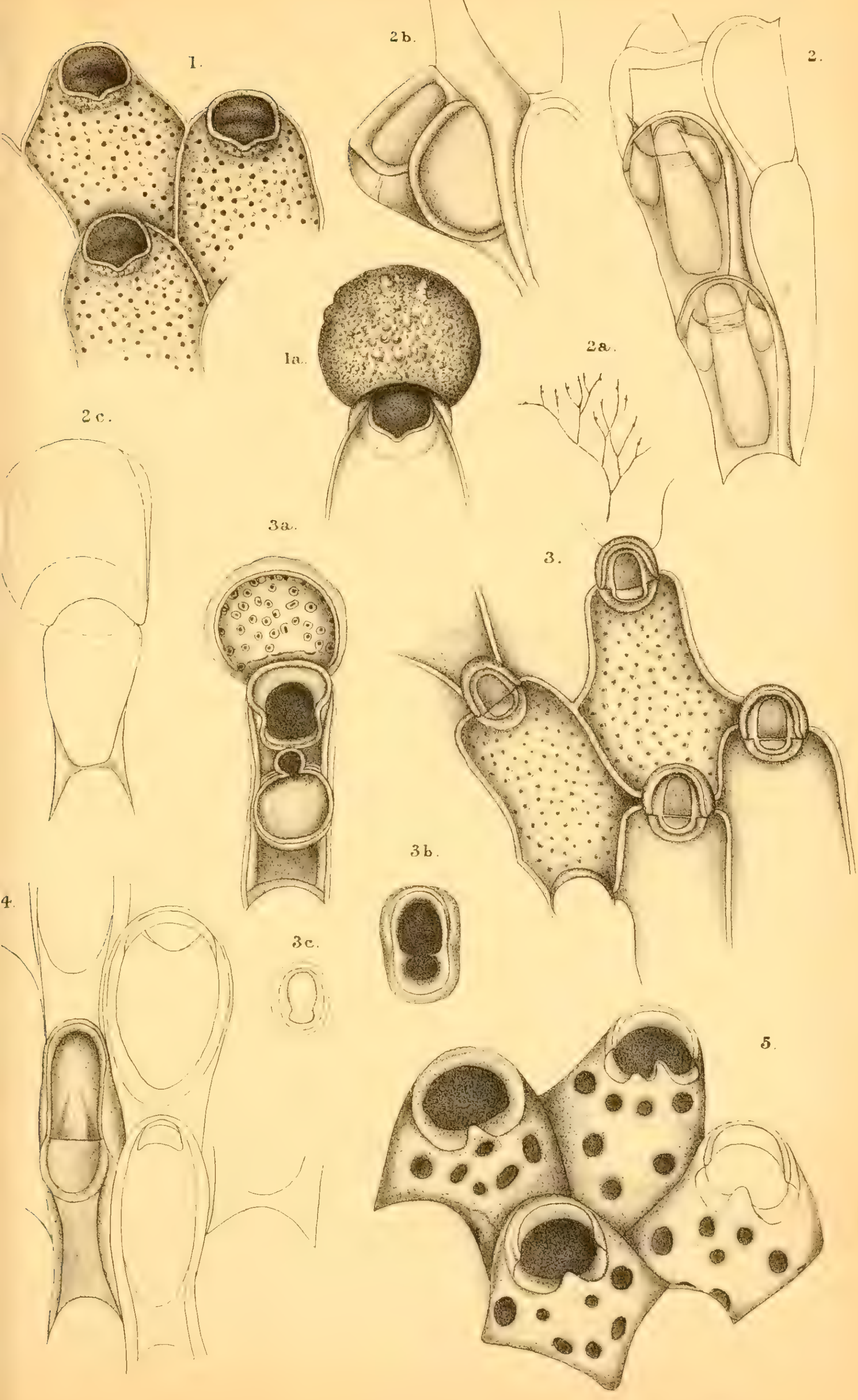

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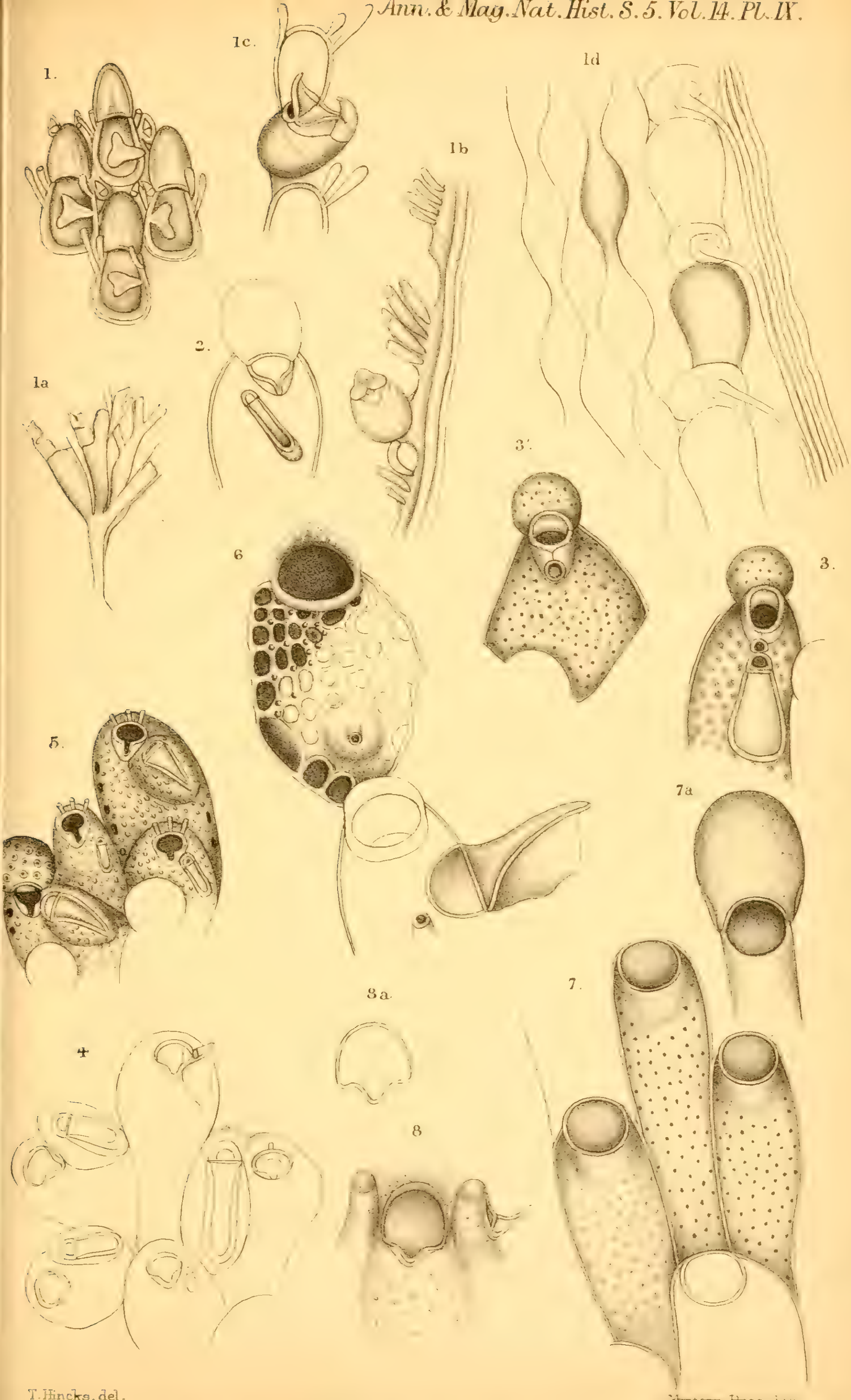

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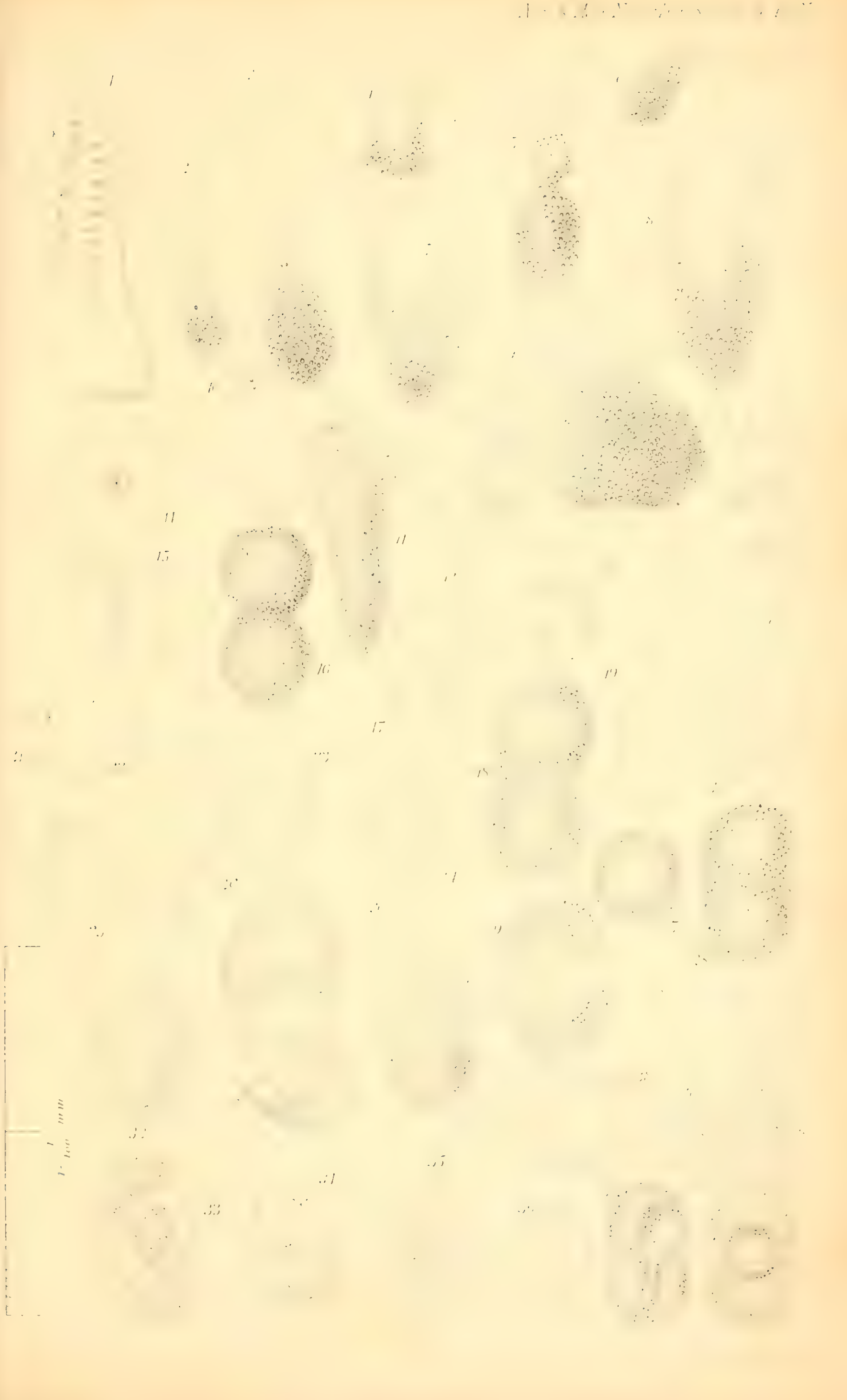

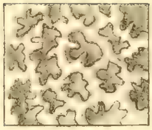

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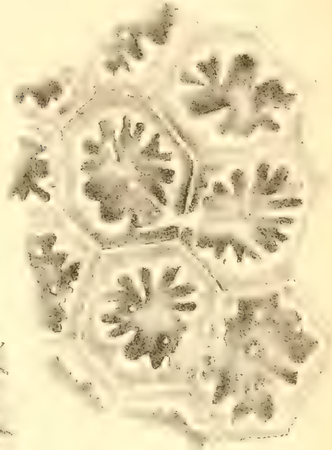

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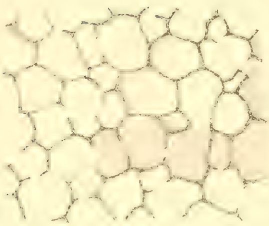

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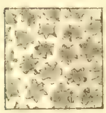

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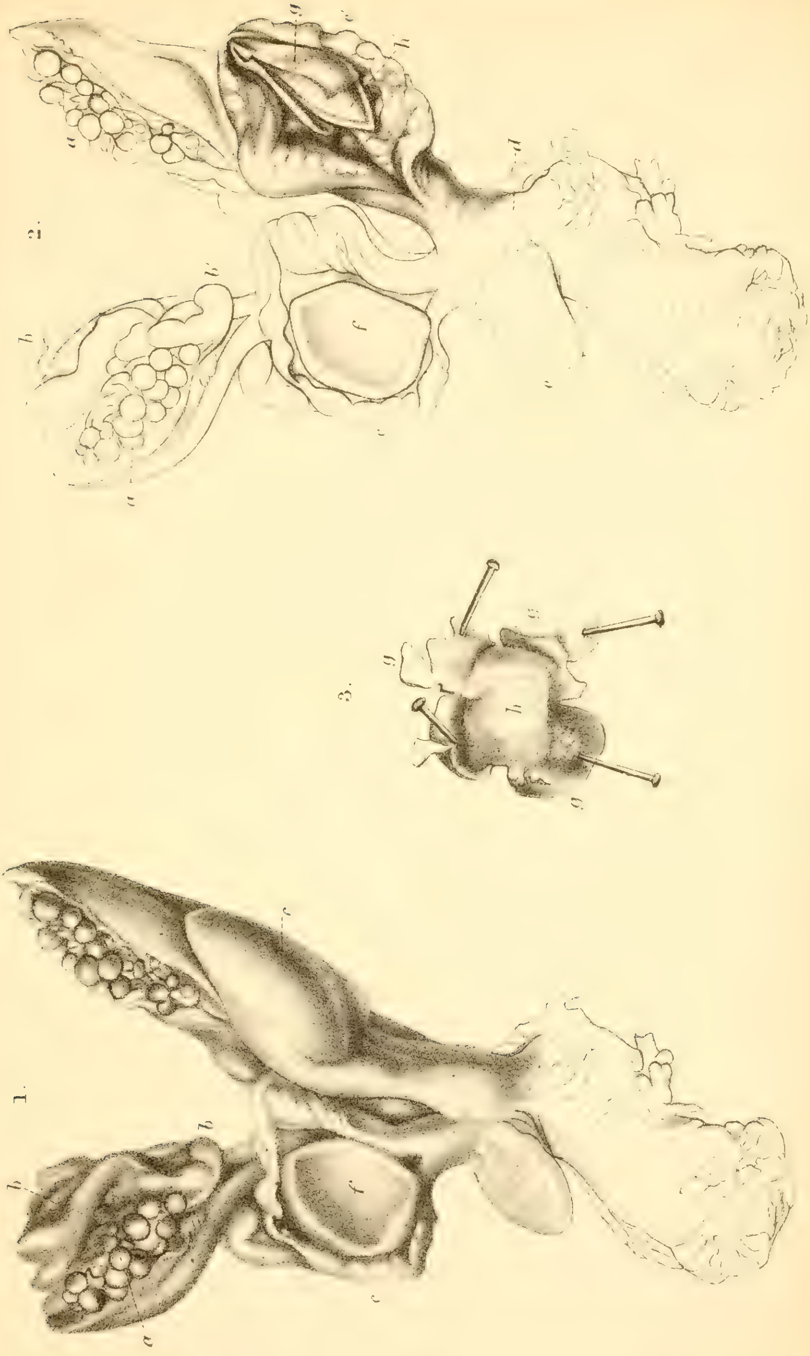
A. S. Foord lith. A. H. F. del.

Mintern Bros imp.



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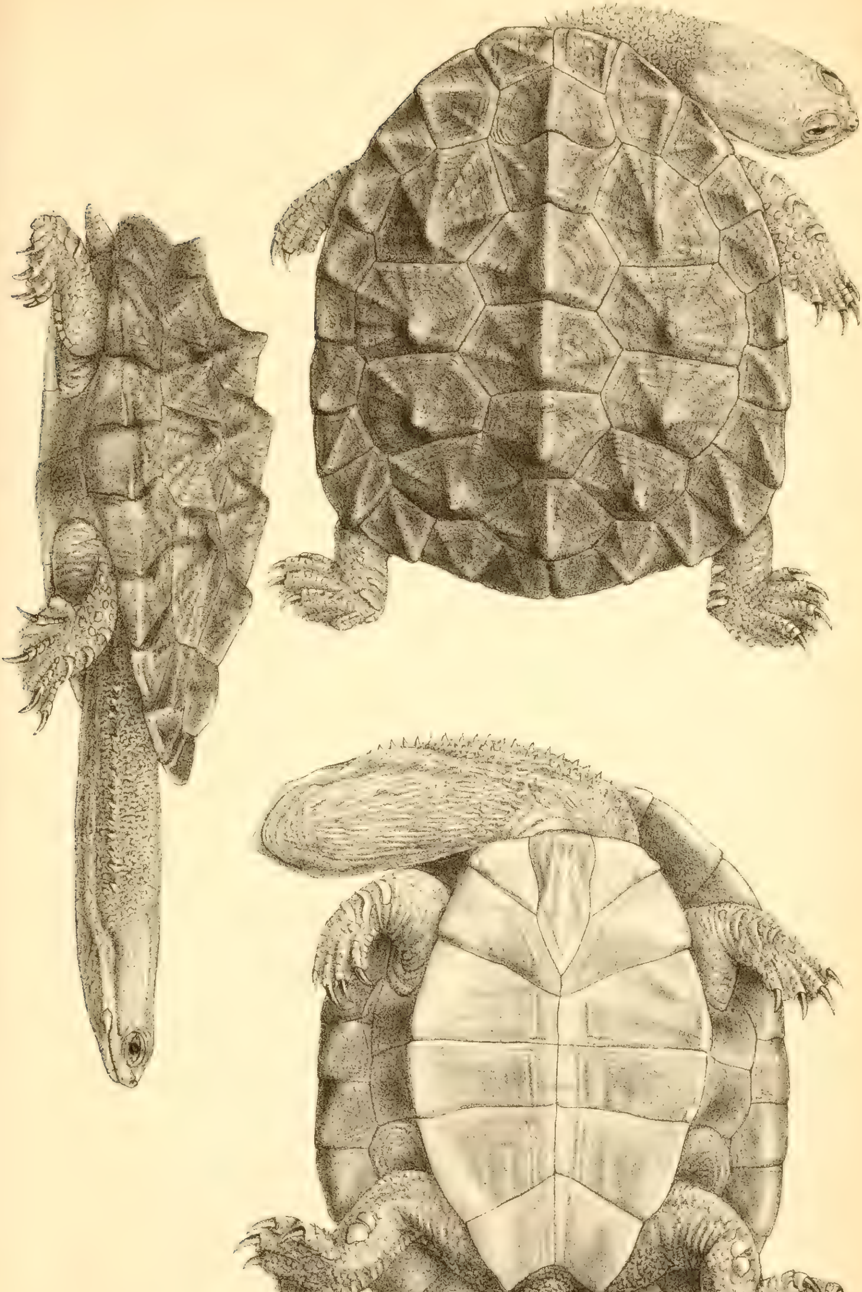
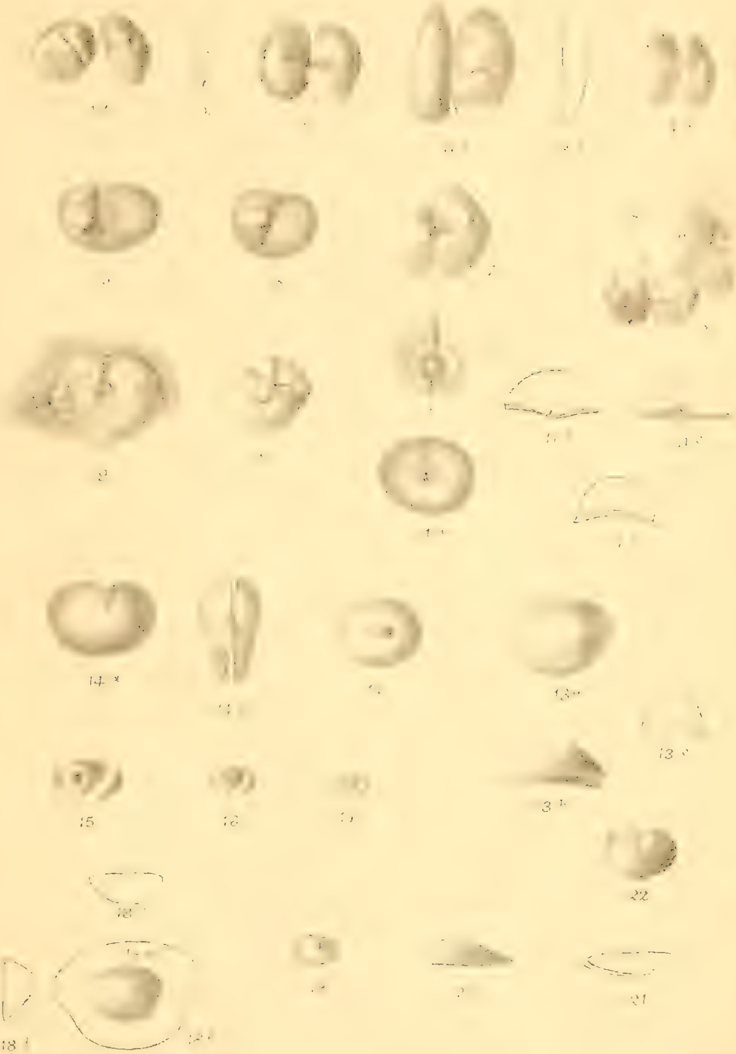


R. Mintern del et lith.

Mintern Bros. imp.

HYDROMEDUSA PLATANENSIS, JUV.



A.B. Woodward lith.

West Newman & C° imp.

Upper-Silurian Entomides.